TP 9036 E

PILOT WEATHER INFORMATION SYSTEM

Prepared for the
Transportation Development Centre
Transport Canada

by Oracle Communications Inc.
G.W.Bachmayer, D.King
J.D. Spaeth

November 1987

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Un sommaire en français de ce rapport est inclus avant la Table des matières.

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17. Abstract

This report documents a research project to develop and demonstrate an automated pilot weather information system for Transport Canada's Air Traffic Services Branch (ATS) in Vancouver, B.C.

The system takes teletype weather information and converts it to high quality, digitized speech which would be available to pilots interactively by telephone and also by radio.

The project was undertaken in two phases: development of the prototype, and testing and evaluation of the system in an operational setting.

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17. Résumé

Ce rapport concerne la mise au point d'un système automatisé de renseignements météorologiques à l'usage des pilotes ainsi que sa mise en service expérimental auprès des Services de la circulation aérienne de Transports Canada à Vancouver (C.-B.).

Ce système a été conçu pour transformer les renseignements météorologiques transmis par téléimprimeur en messages vocaux, synthétisés par numérisation de grande qualité phonique, accessibles par téléphone ou par radio.

Le programme s'est déroulé en deux phases : étude et réalisation du prototype, puis mise à l'essai dans un contexte d'exploitation.

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SUMMARY

As a result of its previous experience in developing and demonstrating a multi-media, multi-modal, interactive transportation information system, Oracle Communications Inc. was approached by Transport Canada's Air Traffic Services Branch (ATS) to develop a pilot weather information system .

In February 1987, the Transportation Development Centre of Transport Canada contracted with Oracle to develop a prototype weather information system for Vancouver. This prototype was to translate teletype weather code into high-quality computer speech and make this information accessible by both radio and multi-line telephone. In addition, Oracle was to provide an on-site recording capability so that new messages could be inserted into the system by the operator.

Currently, ATS provides several types of reports including: SIGMET(Significant Meteorological), transcribed weather broadcasts, terminal forecasts, aviation weather observations, urgent PIREP(Pilot Reports), and NOTAM(Notices to Airmen). These reports are used by pilots to prepare their flight plans prior to takeoff. The weather information on which these reports are based is produced by the Atmospheric Environment Services of Environment Canada and is transmitted nationwide on teletype circuits.

Currently, ATS Flight Services personnel take teletype reports in code from their MIDS terminal, manually translate them into standard ATS word format and manually record them onto a recording and telephone playback unit.

Oracle proposed to automate this process by developing a prototype with a teletype data translation capability that would produce speech reports both with and without operator transcription. It was expected that this system would be more efficient and contribute to improved safety and performance.

Although the project was initially conceived of as a simple transference of technology from one application to another, it turned out to be much more

difficult than anticipated. In the absence of any performance specifications or design guidelines, the project "evolved" over time and included many additions and changes.

Most of the information about the design came directly from ATS operations staff and from the operations manuals used for creating reports. Requirements and desired features were specified at this stage and an initial system design was prepared. Revisions were made many times to the design, reflecting new information about vocabulary size, report formats, and data reliability. These changes raised some serious issues, including: the selection of reports for automation; the accuracy of automatic translation; the creation and editing of new weather reports; the placement of new reports into the telephone menu; and, procedure for the deletion of reports or their designation as "stale". In addition, the prototype had to deal with reports that came in at different or erroneous times because of communications problems. These reports had to be marked by a time/date stamp and placed in a queue for insertion into the system.

Since the final design of the system had to permit both automated and manual verification, a number of operational features had to be considered in the design. These were features which would be required by the operator to use the system. The prototype also required high quality voice and had to provide the same information in both English and French. Finally, the system had to be able to learn—it had to be able to improve and expand upon its knowledge of ATS vocabulary, methods of reporting, and types of errors.

The system actually implemented required some sort of "multi-tasking" capability in order to perform many of the tasks required of it, such as handling the telephone, processing the telex, and building messages. This required the software to be written in a way that broke each task into small self-contained modules that were quickly processed by the system before moving on to the next module.

A pre-prototype system was installed and field-tested at the Vancouver ATS office in August 1987. The system was run and examined daily by ATS staff and performance was recorded. It was found that the system fairly accurately translated teletype data, converted this to digital speech and made this information accessible interactively over the telephone.

Revisions were made to the prototype such as changes to the menu structure and the translation format and additions to the vocabulary.

In November 1987 the prototype was installed at Vancouver International Airport for testing and evaluation until March 1988. The evaluation is being conducted in two phases. The first phase is testing the system "off-line" to determine whether it is technically sound; if the first phase is successful, then an "on-line" testing will be performed to evaluate user reaction to the system.

Based on the experience with the pilot weather information prototype, we concluded that the approach used to the develop the system worked, although the lack of design specifications introduced many problems into the development process.

SOMMAIRE

La firme Oracle Communications Inc. ayant déjà mis au point et expérimenté un système intégré d'information sur les transports pour Transports Canada, les Services de la circulation aérienne (ATS) ont fait appel à cette firme pour se doter d'un système entièrement automatisé de renseignements météorologiques à l'intention des pilotes.

En février 1987, Oracle concluait un marché avec le Centre de développement des transports (CDT), Transports Canada, en vertu duquel elle s'engageait à réaliser le prototype d'un tel système à implanter à Vancouver. Le prototype devait traduire les messages transmis par téléimprimeur en messages vocaux synthétisés de haute qualité phonique, accessibles par radio et par téléphone. Oracle devait, en outre, fournir un dispositif d'enregistrement sur place permettant à un opérateur d'entrer de nouveaux messages dans le système.

L'ATS diffuse des renseignements météorologiques sous plusieurs formes; notamment, les renseignements SIGMET, les bulletins de météo enregistrés et radiodiffusés (TWB), les prévisions d'aérodrome terminus (TF), les messages d'observations de pilotes (PIREP) et les NOTAM. Ces renseignements permettent aux pilotes de préparer leur plan de vol. Les renseignements météorologiques sont eux-mêmes fournis par le Service de l'environnement atmosphérique d'Environnement Canada, qui les diffuse par télex à l'échelle du pays.

À l'heure actuelle, c'est le personnel de l'information de vol de l'ATS qui prend les messages météo apparaissant en code à l'écran du terminal, les traduit suivant la terminologie normalisée de l'ATS, puis les enregistre sur bande accessible par téléphone.

Oracle a proposé d'automatiser entièrement ce processus au moyen d'un système capable de transformer les données transmises par téléimprimeur en messages vocaux, avec ou sans l'intervention d'un opérateur. Ce système allait être plus efficace que la façon actuelle de procéder et contribuerait à une plus grande sécurité de la circulation aérienne.

Ce projet avait été envisagé comme une simple adaptation d'une application technologique déjà réalisée. Mais les travaux se sont avérés beaucoup plus difficiles que prévu. Comme il n'y avait ni devis de performance ni programme des besoins sur lesquels se guider, le concept original a "évolué" avec le temps et a été amplement modifié.

La plupart des données ayant servi à la conception du système ont été fournies par le personnel d'exploitation de l'ATS ou ont été tirées des sections du manuel d'exploitation traitant de la présentation des renseignements météorologiques. Les caractéristiques exigées ou souhaitées ont été définies en cours d'étude du prototype, débouchant sur une première version du système. De nombreuses corrections ont ensuite été apportées pour tenir compte de nouvelles données concernant le volume du vocabulaire à mémoriser, la mise en forme des renseignements et la fiabilité des données. Ces modifications ont soulevé d'importantes questions concernant le choix des rapports à informatiser, la fidélité de la traduction automatique, la composition et la mise en forme de nouveaux rapports météorologiques, l'insertion de nouveaux rapports au menu et le protocole d'élimination ou d'identification des renseignements périmés. De plus, le système devait être capable de traiter les messages répétés ou n'arrivant pas au moment prévu à cause de problèmes de communications. Les communications seraient horodatées et mises en file d'attente en vue de leur entrée.

Le prototype livré devait permettre un accès aussi bien manuel qu'automatique à l'information. Il fallait donc prévoir les caractéristiques nécessaires dès l'étape de la conception. Le système devait aussi produire des messages vocaux s'approchant du naturel intonatif et ce, dans les deux langues officielles. Enfin, il fallait que la base de connaissances et les possibilités du système puissent être étendues : vocabulaire, méthodes de diffusion et reconnaissance des erreurs.

Le système envisagé supposait de faire appel à une certaine forme de "multiprogrammation" pour pouvoir traiter les nombreuses tâches exigées, soit la gestion des appels téléphoniques, le traitement des données transmises par téléimprimeur et la génération et l'emmagasinage des messages. Il a donc fallu structurer les diverses tâches en petits modules élémentaires susceptibles de traitement rapide en mode séquentiel.

Une version préliminaire du prototype a été mis en service expérimental aux bureaux de l'ATS à Vancouver en août 1987. Le personnel l'utilisait tous les jours, puis analysait et consignait les résultats. On a constaté que le système pouvait traduire assez fidèlement les renseignements transmis par téléimprimeur, qu'il pouvait les transformer en messages vocaux et qu'il permettait d'accéder à l'information par téléphone.

Suite à cette expérience, des modifications ont été apportées au menu d'exploitation et à la présentation des messages, et le volume de vocabulaire a été augmenté.

En novembre 1987, le prototype a été installé à l'aéroport international de Vancouver où il doit être expérimenté jusqu'en mars 1988. L'évaluation s'effectue en deux étapes : la première consiste à essayer le système hors circuit pour s'assurer qu'il fonctionne bien; si les résultats sont probants, il sera mis en circuit pour évaluer la réaction des utilisateurs.

En conclusion, on peut dire que la démarche empruntée pour la mise au point du système a été fructueuse, malgré de nombreuses difficultés causées par l'absence de critères de conception bien définis.

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1.0 INTRODUCTION

Oracle Communications Inc. ("Oracle"), a British Columbia based company specializing in computer applications to transportation, was contracted by the Transportation Development Centre (TDC) of Transport Canada to develop a prototype automated pilot weather information system(PWIS) which would convert teletype weather data to high-quality computerized speech. This system was to be installed and evaluated in Air Traffic Services (ATS) operations.

This report describes the development of the prototype. **Specific details about the current operations including technical descriptions of methods and approaches are not included here.** The reader is referred to relevant operations manuals where appropriate. A **Users Manual** for the Pilot Weather Information System is attached as Appendix A. This manual provides detailed information about how the prototype works and is intended to guide the operator through the system's features.

1.1 History of Project

Oracle has developed a multi-media, interactive, transportation information system, called ITIS, which it demonstrated in Vancouver during EXPO 86. The system made available to the public a variety of transportation information including transit, ferry, traffic, parking, inter-city bus and rail, and border crossing. The public could access the information by video terminals located at SkyTrain stations, by telephone, or by radio. Both real time and scheduled information was accessible.

ITIS required the development of high-quality computer speech both for telephone applications and for radio. This computer speech was of particular interest to several Transport Canada agencies, specifically Coast Guard and Air Traffic Services (ATS), who viewed the technology as potentially improving safety and increasing the efficiency of their operations.

Although both agencies had invested considerably in new technology for their operations and had a history of supporting research and development in computer speech applications, particularly text-to-speech systems, neither had yet experimented with an Oracle type system.

Because of the immediate needs and interest in the system by ATS, Oracle proposed to take standardized electronic weather data, transmitted over teletype lines, and convert this directly to high-quality computerized speech which would then be available to pilots over telephone or which could be broadcast by radio transmitter. A demonstration of this technology was timely because ATS was considering replacing its existing weather and aviator information system and was looking for more efficient, reliable, and economical technology.

Transport Canada's Transportation Development Centre (TDC), which is responsible for supporting transportation research and the development of innovative technology, became interested in the proposed pilot weather information system because of its previous support of the ITIS technology and also because it wanted to".....develop expertise, techniques, and equipment in support of airways services for the improvement of safety, efficiency and productivity in Canadian air operations."

In February 1987, TDC contracted with Oracle Communications to develop a prototype weather broadcast system for Vancouver. The contract also called for Oracle to provide a recording capability that would permit ATS staff to record non-standardized messages directly into the system and to show its automated compilation and record-keeping capability.

1.2 Existing Situation

The typical message which ATS produces consists of the following elements:

- Station Identification and Introduction
- WSCN - SIGMETS within 500 NM radius of Vancouver
- FACN20 - Plain language synopsis of forecast weather for South Western British Columbia
- UACN - Selected Pilot Reports (PIREPS) within 100 NM radius of Vancouver. (Selection made by flight service specialists)
- SACN - Hourly and special weather reports for Vancouver

(YVR), Abbotsford (YXX), Victoria (YYJ), Bellingham (BLI), Nanaimo (YCD), Comox (YQQ), Merry Island (WMR), Whistler(Alta Lake)(WAE), Hope(YHE).

- FTCN – Terminal forecasts for Vancouver(YVR) and Abbotsford(YXX)
- NOTAM - Notices to Airmen for airports and facilities within a 100 NM radius of Vancouver. These will be included until the affected period expires or until it is cancelled.

The weather information on which these reports are based is produced by the Atmospheric Environment Service (AES) which is responsible for providing or arranging for the provision of meteorological service for aviation.

Pilots avail themselves of aviation weather, NOTAM information, and any other information that will assist them with preparing their flight plan prior to take off. Most of this initial information is available by telephone, or in person. Enroute, pilots can access weather information on specified frequencies or, if urgently needed, from Flight Services personnel.

AES generally prepares or reports the following meteorological reports and forecasts which are specifically relevant to pilot pre-flight briefing by telephone and radio:

•SA's—are coded weather observations that are taken each hour at various airport and enroute locations in Canada. Special weather reports are also issued when special circumstances arise.
•FA's—are regional forecasts issued in abbreviated plain language and issued on a routine or request basis as required. These forecasts are prepared four times daily and are valid for 12 hours with an outlook for 12 hours.
•FT's—are airport terminal forecasts prepared by nine weather forecast offices for 160 terminals across Canada. These forecasts are limited to terminals for which SA's and special reports are available. These forecasts are prepared four times daily and are valid for 12-24 hours.

•PIREPS—are weather observations reported by pilots in flight and entered into the system.
•SIGMETS—are reports of significant or severe weather.

Flight Services personnel take printed copies of the teletype reports from the MIDS terminal, manually translate them into standard ATS work formats, where necessary, and then manually record the reports onto an ASSMAN MET-100 recording and telephone playback unit. This unit is a 10 track, audio deck which can handle four incoming telephone lines. The recording and telephone playback units are functionally separate but are integrated with ATS's library—a record keeping system which stores all weather and other reports. Abbreviations, vocabulary used, and transcription procedures generally comply with the Department's Manual of Abbreviations (MANABS).

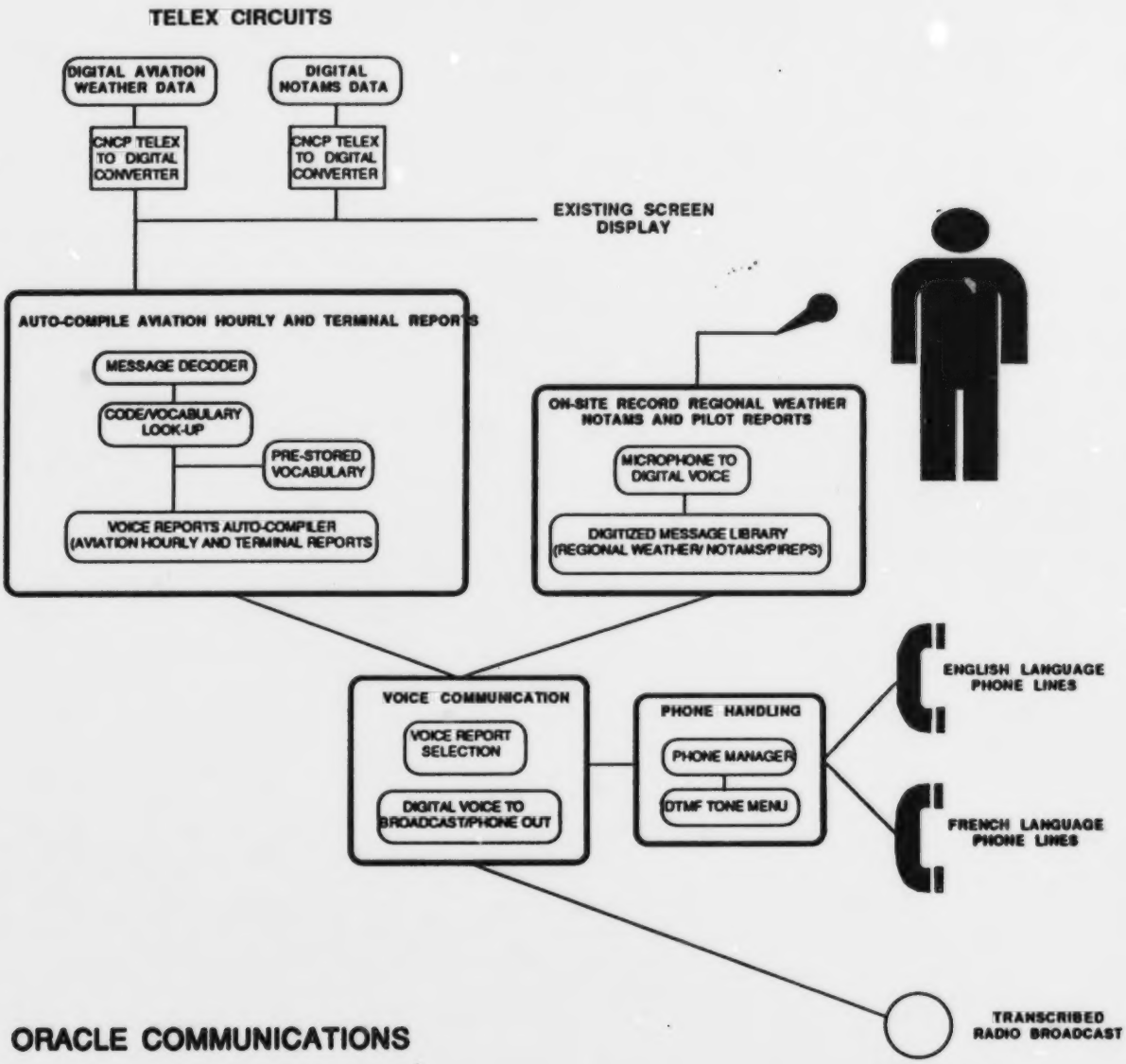
An automated approach would simplify this procedure. A micro-computer based prototype would perform a number of different functions: it would monitor the teletype circuit and identify and grab any relevant information (in the form of reports); it would queue the messages according to some pre-defined order; it would display the original teletype code and its English text translation; it would translate the English text to speech (in English and French); and, it would answer telephone calls (as many as required) and provide radio broadcasts. In addition, some other features which could be added would permit either manual or fully automatic verification of the messages and the on-site recording of new messages and their insertion into the system. Exhibit 1 illustrates the automated approach.

The expected benefits of a functioning prototype include:

- More efficient operations
- Reduced operating costs
- Improved safety
- Increased equipment reliability

EXHIBIT 1. Automated Approach to Aviation Weather

DIAGRAM OF AVIATION WEATHER DEMONSTRATION



ORACLE COMMUNICATIONS

2.0 TECHNICAL ELEMENTS

2.1 Identifying the Design Requirements

2.1.1 The Process

Three sources of information were used to prepare the design and identify issues in the design of the prototype system: ATS service operation personnel; ATS operations manuals; and, AES weather office personnel.

After the initial contacts were established in each relevant Department, and the various manuals obtained, principally MANABS and MANOBS (Manual of Observations), an iterative process was established for reviewing each component of the problem.

To illustrate, a review of the **hourly messages** involved the following process: an initial discussion was carried out with the operations personnel to obtain their description and understanding of the hourly reports; then, a template of the hourly report was prepared; this template was tested by comparing it with the teletype data, to determine its accuracy and reliability; and, finally lists of problems were identified and taken back to operations personnel for review. This cycle was sometimes repeated. At the end of the process, a statement describing that particular aspect of the system was forwarded to ATS management for their final comments and approval.

2.1.2 Developing a Computer Tool

The project was initially conceived as transferring existing technology, in the form of Oracle Communication's voice system, to the working environment of the Air Traffic Services aviation weather information service which is currently a mainly manual operation. Oracle was asked, implicitly if not explicitly, to ferret out the appropriate design for the prototype system, since no design requirement specifications had been formulated by ATS. Oracle had, up to that point, no experience with ATS or pilot weather information.

Conventional wisdom in the systems design field states that this approach could be disastrous because the tool-maker (Oracle) was taking the lead in

the design, rather than the tool-user (ATS). Developing system design requirements is often a long and laborious process, which operational people (the tool-holders) are usually not in a position to do. As a result, system design is often done by those with some familiarity with the "hands-on" operations, and some familiarity with systems, but who are not experts in either. However, when there are no concrete tools or a common frame of reference in the communications between operators, designers and tool-makers, significant considerations sometimes get lost.

This project involved direct communications between the operators in the field and Oracle. About one-third of the time put into the project was spent communicating between these two groups. Operations personnel were extremely co-operative in this effort.

Whether this approach taken by Oracle is superior to the "design first" approach is uncertain. Clearly a rigorous design effort must be undertaken at **some** stage in the development of a new computer tool. Having a concrete, working prototype available at the outset as a reference point enables any design discussion to be less abstract, and therefore more meaningful. However, it also requires considerably more effort, time and resources.

2.1.3 Initial System Description

Oracle began the design process with a detailed review of all ATS and AES procedures and operations manuals that defined aviation weather information reporting processes, procedures, and protocols. ATS operations staff then provided Oracle with information about their actual daily procedures and operations, including the pilot information telephone line, and printed several samples of the AES weather bulletins which their service provides. Oracle analysed these bulletins and discussion focussed on these printouts (see Appendix B). Oracle was advised that the vocabulary required would comprise about **500** words, since the AES/DOT combination of rules for report presentation controlled the size and content of the report vocabulary. Reports used by ATS came in two formats: English natural text, such as the FACN20 (Transcribed Weather Broadcast); and, abbreviated code lists, such as the SACN1 hourly weather (see Appendix B). Both types of reports were processed through the AES.

computer system before arriving at ATS on the teletype circuit. Oracle was advised that both types of reports followed a standard and rigorous format. Because place names occurred in the sample printout we concluded that, theoretically, any local place name could occur. This was a significant revelation because the possibility of tens of thousand discrete place names raised the problem of how to deal with these in a system that uses pre-recorded vocabulary.

Initially, based on a review of sample reports and discussions with ATS personnel, Oracle assumed that the computer-entered data was standardized and verified to typical levels of computer operation. As we became more familiar with the reports we noted that the reports were much more complex and ambiguous in practice. Reports broke their own rules sufficiently often that a great deal of unexpected work arose in the project requiring significant alterations to the design of the prototype simply to error check the raw report data and deal with aberrations.

The formats of the voice reports which were available by telephone and radio were also discussed with operations personnel. Based on these discussions a telephone menu was designed (see Appendix C) which was reviewed and approved by ATS, and produced a series of output format templates for each type of weather report which the prototype had to prepare.

2.1.4 The Initial System Design

Based upon our initial understanding of the service provided by ATS (described above), the Pilot Weather Information system prototype was conceived principally as a translator of the teletype reports, which were to be placed into a telephone menu to be heard by callers desiring weather information. We offered the operator the ability to replace a report manually, and to print and display the reports as they came in. In this design we assumed that Oracle would be able to identify the vocabulary, create it, and permit operators to add to the voice/text vocabulary from time to time as the vocabulary changed. The system was to include a record keeping function about both the teletype reports processed and the operator input.

2.1.5 The Vocabulary

The actual vocabulary for the ATS weather service was determined to have three components: a **standard vocabulary**, with less than 5000 words and phrases; a **place name vocabulary**, which is unlimited; and, a **colloquial portion** of the standard vocabulary, which may vary slightly by operator, or among AES weather report input personnel. Standard vocabulary comprises over 90% and perhaps as much as 98% of vocabulary issued in typical hourly observations and terminal forecasts and perhaps 50-70% of other reports.

2.1.6 The Report Formats

Although coded reports, such as hourlies and terminals, have a standard format, which includes the encryption of numbers according to set rules (see Appendix B), and the use of the MANABS abbreviations for almost all text, the meaning of some elements of a report are dependent upon understanding the **context** surrounding that element.

For example, a typical SACN1 hourly weather report could be:

*YCP SA 2100 **15** SCT E150 BKN 220 OVC **15** 277/8/-12/0000/985/AC2=*

In this report, the number 15 (highlighted in bold) represents the **visibility,** while the number 15 (not highlighted) represents a **cloud layer height.** The only certain way to determine that the bold 15 is the visibility is to recognize the meaning of the text before and after that number. There is no assurance that the information before and after the temperature field will always be the same type of information. In programming terminology, the report has a free format structure, with ambiguous field definition.

2.1.7 Level of Data Reliability

Another problem affecting programming was discovered part way through the project. Reports, **while they are entered** into a computer system, are not validated in any automated and reliable fashion. This shortcoming

results in reports which contain both erroneously entered data, and items which a human being could recognize as errors but can make into useful and unambiguous reports by deciphering its meaning. However, it is much more difficult for the computer to interpret meaning. An example of the first type of error would be the notation: "SUN & RAIN", in the comment area of a report. The use of the ampersand is specifically forbidden (hence this is an incorrect entry) although in this case the meaning can be safely assumed. An example of ambiguous meaning would be a three digit number in the wind field. Wind information is specified as a four digit number, and therefore the meaning of the three digit number cannot be safely deduced. Random errors can also be introduced into the weather reports by the teletype circuits and other elements of the communication network. These types of errors are sometimes signified by the substitution of question marks for the lost data.

Sometimes the time/date stamp is erroneous. Although in theory the teletype information is supposed to be a time-based stream of data marching forward in real time, in practice, reports which have a time/date stamp which precedes other messages are **posted** on the teletype system. Usually this occurs in one of two ways: the originating station for the message was down for some period, but succeeded in posting the report later on; or, the time/date stamp is erroneous. These time/date stamps become a real problem in the context of the SACN1 hourly weather bulletins, which must be updated when the first set of "new hour" messages come in. Sometimes there is no way to distinguish from the information stream when a "new hour" time/date stamp is erroneous.

2.1.8 Frequency of Occurrence

Six types of reports used by ATS Vancouver for the pilot information service were considered by the project for automated voice handling: hourly weather reports (SACN1's); terminal forecasts (FTCN's); transcribed weather broadcasts (FACN20's); SIGMETS (weather warnings); PIREPS (weather received from pilots); and NOTAMS.

Generally speaking, hourly reports occur 24 times a day, terminal forecasts 4 times a day, and transcribed weather broadcasts twice a day. The other reports occur at random, according to circumstances.

2.1.9 Additional Design Requirements

The above factors (increased vocabulary, report formats, and data reliability) identified several new design issues:

- How to develop context-sensitive decoding of weather reports.
- How to ensure that errors in reports do not slip through the automated process.
- How to give the operators an easy way to correct and validate reports.
- How to deal with the 98% standard vocabulary and the 2% unlimited vocabulary.
- How to maintain sufficient automation so that the system can be a labour-saving device.

These design issues are discussed below.

2.2 System Design Issues

2.2.1 Criteria for Resolving Design Issues

It was important to remember that the system was to be a prototype intended for ATS personnel to evaluate its potential usefulness as a production system that could be put into regular use. Once the issues were clarified, it was evident that there was not enough time or money to provide every feature that could be used in regular operations. Instead, it was necessary to concentrate on developing those features which were considered essential to establish the feasibility and benefits of the prototype. Also, it is important to remember the practical differences between a prototype and a production system. A prototype is developed to demostrate capability, while a production system is expected to perform day in, day out. Consequently, the same objectives may be implemented very differently in the code of each.

2.2.2 Selecting Reports for Automation

Of the six catetgories of reports that were initially candidates for automation (hourly, terminal, SIGMETS, PIREPS, NOTAMS, and TWB) the hourly weather and terminal forecast reports consume most of the operator's time (about 15 minutes per hour is spent preparing these reports). Obviously the benefits of automation would be most noticeable here, even though these two types of report included some processing problems which required intelligence to be built into the prototype. The prototype would generate both the full text and voice versions of these reports. Because other reports such as, SIGMETS, PIREPS and NOTAMS exhibited a high frequency of unusual vocabulary and non-standard format they were not good candidates for automation.

Transcribed Weather Broadcast, is a natural language text report which did not present any unusual processing problems (unlike the hourly and terminal reports). Because its vocabulary requirements were larger than those for the hourly and terminal reports a decision was made to let ATS create the voice vocabulary for this report. Once they had the prototype they could use the software developed for the hourly and terminal reports to generate TWB reports also.

SIGMETS, PIREPS, and NOTAMS exhibit a larger proportion of specialized vocabulary (e.g. place names) and do not have as rigid formats as SA's or FT's. Accordingly, it was decided, at the prototype stage, to handle these by a recording system

2.2.3 Automatic Text and Voice Translations of Teletype Weather Reports

The context-sensitive and error-prone characteristics of the teletype weather reports posed some real challenges for the design of the prototype system. A variety of techniques was utilized to deal with these issues.

Each report was first broken up into text tokens which were tentatively identified as belonging to a particular area of the report. Each particular report area was then processed separately. Text tokens were checked against the current vocabulary list belonging to that area of the report.

Tokens which failed to match the vocabulary were marked "bad". Certain minimum information was sometimes required for certain report areas. These checks were made against the good tokens. A report area which failed to meet the minimum tests was marked 'bad'. Conflicts, collisions, and confusion could occur at the boundaries of the original report areas established by the system. After parsing the report, the boundaries could be reset if sufficient hard information was available. Some areas required that certain patterns occur within them. Here pattern tests were carried out, and failures were marked as 'bad'. Some areas could only be identified by their context. Similar pattern tests were carried out in a cross-area fashion. Certain report areas were identified by ATS representing an **absolute** minimum for translating any part of the report. If any of these areas failed, the entire report was marked 'bad'.

Once an hourly or terminal report had been processed in this way, each good token had associated with it some full text and voice file.

Both the pattern and minimum tests were **hardwired** (i.e. they were performed by the system without operator control) into the prototype code. This was done for speed and efficiency to develop the correct algorithm quickly. However, these tests could be made explicit in a production system and remain under the control of an operator.

The process of developing this code was based upon translating many thousands of actual teletype report (test files), and verifying the outcome. A representative sample of about 1000 outcomes was translated and approved by ATS operations personnel.

Typical examples of the various situations that the processing will now handle correctly are described below:

- Individual letters which have different meanings depending on the location within an hourly report. For example, the letter 'E' may mean EAST, or ESTIMATED CEILING, or ESTIMATED in different contexts.
- Hourly weather reports **must** locate visibility information **between** the cloud layers area of the report and the telemetry fields, which must be contextually identified:

*YCP SA 2100 15 SCT E150 BKN 220 OVC **15** 277/8/-12/0000/985/AC2=*

--- cloud layers ----- ------ telemetry ----

A variety of errors can occur which make identification of this field very difficult for a computer system, such as:

*YCP SA 2100 15 SCT E150 BKN 220 OVC **15** 8/-12/0000/985/AC2=*
(missing one telemetry field)

*YCP SA 2100 15 SCT E150 BKN 220 -OVC **15** 277/8/-12/0000/985/AC2=*
(erroneous cloud layer descriptor: -OVC)

- Minimum criteria tests including numeric parameters for barometric pressure.

This combination of processing techniques allowed a very broad range of report content to pass the automatic processing function either fully translated or with one or two questionable tokens marked for examination by the operator. It also maintained a very high level of scrutiny against errors, since a report may fail a variety of tests. It generally follows the maxim: "If it cannot be identified precisely, then it must be wrong".

There was one exception. The **comment area** of all reports generally permitted any combination of words or codes. No attempt was made in the software to enumerate **all** undesirable combinations (which would be virtually impossible). Therefore the comment *"SKY ALL FOG SKY ALL SUN"* which is obviously nonsense, would be permitted because it could be translated by the system. Visual verification, and perhaps modification of all reports would be required before they become available to the public.

2.2.4 Creation and Editing of Weather Reports

Section 2.2.2 identified another requirement that **some** reports may require operator editing and that **all** reports should be verified before being placed in the phone menu. To satisfy this requirement, the operator must be able

to do the following things: change the text of a report; record all or part of the speech for a report; see the report text; hear the report speech; and, redo the text/speech for a report.

The operator should have the initial choice of editing or placing the fully translated reports into the phone menu. Partially translated or untranslated reports should immediately go to the editing function.

2.2.5 Placing Reports into the Telephone Menu

The telephone menu that a caller will interact with is diagrammed in Appendix C. This menu was reviewed and approved by ATS staff. The specific reports under "Press One", "Press Two", etc, may be singletons or a group of reports of that type. The prototype automatically places the various weather reports into the menu once the type of report is identified and the report is verified.

ATS identified a particular sequence for dealing with messages within each category of weather report. This sequence was different for each type of report and involved different procedures (see MANOPS). PIREPS and NOTAMS could only be removed by operator judgement, since no explicit criteria exist for removal. SIGMETS included procedures for removing previous reports. These three types of reports were assumed to be placed into the prototype system menu in the order in which they came. On the other hand, the Transcribed Weather Broadcast report replaced itself approximately every six hours, while the terminal forecasts did so at approximately three hour intervals.

Hourly reports and terminal forecasts were to be placed in the menu in a certain order by originating station. Although this control was hardwired into the prototype code, it could be made flexible in a production system. Also, certain rules which apply to the updating of hourly reports when an hourly SPECIAL report comes along were hardwired into the code. In addition, format changes were hardwired into the code. By automating these types of provisions in the code, the amount of time the operator must spend organizing the new reports into the phone menu is minimized.

In a production version, it would be desirable to allow the operator to set up the phone menu categories as pigeonholes into which reports would drop in a certain order. It would also be desirable to allow the operator to establish a set of rules by which a report can be generated from several sets of data (i.e. the hourly SPECIALS generated from two hourly reports). This type of flexibility was not required, however, to allow ATS to test the operational usefulness of the system.

2.2.6 Time Stream of Information

In principle, weather information is collected and made available to the public in a tightly-regulated and time-dependent manner. Although this is generally true, schedules are sometimes disrupted by the temporary loss of some portion of the communications network. This results in reports which may be "stale" and a system that may receive updates at any time.

Since the timing of automated reports, particularly hourly reports, is especially critical once the new hourly information is received by ATS, it must quickly replace those portions of the old information that it updates.

Although this would normally be a trivial problem for an automated system, in the case of the AES reports the time/date stamps placed on the teletype weather reports were not reliable. They may have been corrupted by communication problems, entered erroneously, or a report for an earlier time may have been placed on the system. In this situation the prototype was required to monitor the time/date stamp of incoming reports, advise the operator of a possible discrepancy, and finally, update the phone menu reports only after the operator has verified the new reports and their time/date stamps. This last design criterion had to be very carefully applied in the case of the hourly reports. ATS required the following rules to be applied to hourly report updates:

a) replace the old report with the new report when there is one
b) edit the old report to indicate one hour stale status if no new report
c) replace a two-hour stale report with a "delayed" message.

These rules were, however, quite difficult to include in an automated system

since the update could only be carried out when reports for the new hour had come in and been verified by the operator. The system design cannot require the operator to respond instantly to a request for verification since the operator may have pilots in the sky to deal with, or any of a number of higher priority tasks.

In addition, reports could come in from the teletype as a group, or as singletons. In either case, the report(s) are contained within a bulletin, a special generic AES teletype format which includes the report type identifier and the time/date stamp of that group. Usually, but not always, the first bulletin of the new hour contains several reports. The PWIS system stacks the new reports in a queue until such time as the operator can deal with them.

A sequencing problem can occur once reports are placed in a queue. The operator could verify the first bulletin of reports for the new hour. The system should then update the phone menu as soon as possible so that callers hear the most recent verified information. However, the system cannot wait for an indication that all the reports for the new hour have arrived because they may not all arrive this hour. Therefore, immediate updates after verification have to include the stale marking of old hourly reports for which there was no replacement. This will occur even though there could be new hourly messages for one or more of the stale-marked stations waiting in the verification queue but in bulletins which follow the first bulletin of the new hour in the teletype stream. By definition, these second, third and so on bulletins will not have been verified by the operator at the time the first bulletin has been verified. If sequencing collisions like this are not tested for, the operator could verify the new hour message, only to receive immediately a stale status update for that station.

This issue illustrates a number of principles that were important for the system design:

- the system must stack incoming teletype reports for the operator to verify and edit;
- the system must stack verified reports for insertion into the phone menu according to the update rules given by ATS;
- the system must check for, and avoid, "reverse-order" collisions among the queued reports.

The prototype system permits a maximum number of reports to be stacked up. These stacked reports could equal approximately two or three hours in duration (which surpasses the operating requirements for the ATS service).

2.2.7 Labour-Saving versus Human Verification

Section 2.2.3 explained what steps had been taken to assure that fully and correctly translated reports were automatically prepared by the system. It also indicated, from a reliability assurance perspective, why automated reports must be verified by a human operator. To permit both automation and verification to be practised effectively, a number of operational factors had to be built into the design:

a) the operator must be immediately notified when receiving a translated report
b) the operator must be constantly reminded of reports waiting to be verified (although this capability should be under operator control)
c) once the operator selects the next report for processing, the report should appear, with an indication of its status (translated, partially-translated, or not translated), and with the most appropriate functional choices immediately available to the operator in order to minimize the time spent on the report
d) the operator must be able to withdraw from interaction with the system at any point in the interaction without harmful affects to the operation of the system
e) the operator must be able to return to the interaction at the point of departure and continue
f) the operator must be able to change the reports, both text and voice, quickly and efficiently
g) where possible,the system should learn from previous changes made

2.2.8 Voice Quality and Recording Capabilities

The system required high quality voice in order for the callers not to have difficulty hearing and understanding the messages. Although Oracle had high quality voice already, it continued to investigate methods to further improve quality and permit professional style on-site recording. The initial quality of the audio signal was acceptable for telephone applications but some noise reduction was necessary for the speaker/microphone application. This was accomplished by including a high-pass and low-pass filter to eliminate the worst of the noise.

This feature was essential because the system required report alteration and entire-report recording—the system had to be able to record voice messages, play them back for the operator to check, and re-record them if necessary.

2.2.9 Requirement for Two Languages

Because the ATS service provides the same information in both French and English it was a project requirement that the prototype had to be able to do so as well. There were several methods by which a multi-language system could be implemented. For the prototype, it was decided to implement the choice of language as an initial selection, made at the time of system re-boot. Although this would demonstrate the capacity to operate in either language, it required the system to be re–started in order to switch languages.

2.2.10 Auto-verification of Reports

ATS staff asked that the system be able to run with auto-verification of translated reports, for unattended operations during testing and evaluation of the prototype. This feature was implemented in a very limited fashion. Hourly or terminal reports which are translated imperfectly by the PWIS system are simply placed on line with the untranslated portions dropped out. It was understood that this feature would not be used in an online system, so this limitation should not be a problem.

2.2.11 Integrating the Teletype, the Telephones and the Operator

The existing ATS telephone service was continuously available to the telephone caller, while concurrently new reports were entered into the system by either the operator or from the teletype. The prototype had to at least maintain this level of service, and from the perspective of labour-savings, had to improve on the current system.

For a computer system to perform these concurrent activities required a system which operated on a real-time basis. That is, when a telephone call comes in, it was immediately answered and the caller received the current set of messages. Since the nature of the teletype information is that of a constantly flowing stream of information, the teletype stream had to be constantly monitored, and relevant reports extracted and processed. Since the operator could request to interact with the system at any time it had to be designed to let him do so. Operator interaction with the system could be by screen, keyboard, recording equipment, or printer.

All these activities had to be accomodated as though they were all occurring at once. That is, the caller must be able to hear the current messages while the operator may be updating them, and while the newest teletype report may be getting decoded by the automatic portion of the system.

This requirement meant that the software had to be internally multi-tasking (i.e. be capable of doing more than one thing simultaneously) in the sense that no one task is carried on for any externally-significant length of time, and yet that task can be easily returned to (See Section 2.3.1).

2.2.12 The Knowledge-building Process

Althought self-learning computer programs, in the true sense of the word, are a myth at the present time outside of carefully-controlled experiments with small problems and very large computers, it was desirable that the system be able to improve and expand upon its knowledge of ATS

vocabulary, methods of reporting, types of errors and also expand and change as the contents of the service changes.

A practical approach is taken by many commercially-available knowledge-based systems. The users of the systems have available to them mechanisms to extend and refine the knowledge base of the system. These types of features were also built into the prototype TWB system. Adding to the text/voice vocabulary was a relatively straight-forward issue. The user could identify a text string and associate it with one or more vocabulary elements in the ATS library which is then associated with some speech.

2.3 Implementing the Prototype Design

2.3.1 Oracle's Basic System

Oracle brought to the project its basic voice processor system, which included the following features:

- telephone handler including DTMF tone input
- compiled digitized speech
- telephone menu compilation.

This basic system was expanded to fit the requirements and meet the design criteria for the ATS system identified above.

2.3.2 The "Frenetic Susan" Revolving Processor

In order to handle the several simultaneous demands which must be placed upon it, the system took the "lazy susan" approach to processing all tasks. The main loop of the program looked at the telephone-handling equipment, then the keyboard/printer and then the teletype circuit to see if some task was in progress or if some event was waiting to be served. Each task in the system, whether it was building a disk file, analysing a teletype report, or processing a keystroke, was divided up in such a way that a minimum of activity occured before control was returned to the main loop. In effect, it was as if the demands placed upon the system were sitting around a large

table grabbing some processing time as the centrepiece revolved past. This required that each task had to be broken down into small pieces which could be returned to the next time that its turn came in the main loop.

2.3.3 Compromises to the Final Prototype

Section 2.2 described in some detail the various design requirements that were targetted for the prototype. During the development of the prototype, it became clear that time was not going to be available to meet all the requirements specified. Accordingly, decisions were made to curtail or drop certain features while fully implementing others. The features that **were implemented** included:

- automatic identification of all desired teletype reports
- automatic translation of hourly and terminal forecasts into text/speech messages
- operator-driven placement of messages in the telephone menu for all categories of ATS report: SIGMETS, PIREPS, NOTAMS, hourlies, terminals, Transcribed Weather Broadcasts
- display, printing and message removal for the messages in the telephone menu
- display and verification function for stacked incoming teletype reports
- editing functions for fully-translated, partially-translated or untranslated weather reports, including both text and voice changes
- capability to create weather reports from text in the system vocabulary at operator command
- capability to run the system in English or French voice
- capability to run the system in an auto-verification mode
- capability to save all selected weather reports and text translations to disk
- capability to save all translation errors to disk for later vocabulary building

The following features **were not** included in the prototype system:

- Automatic translation of the Transcribed Weather Broadcast report. This represented no new achievement for the system over the translation of hourly weather reports and terminal forecasts.
- Automatic translation of PIREPS,SIGMETS, and NOTAMS. This would require both larger vocabulary and some additional format handling capabilities.
- **On-line** changes and improvements to the text/voice vocabulary could not be made. However, vocabulary could be further expanded **off–line**.
- User-defined online adjustments to the knowledge base and decision rules for translating teletype reports to voice. It was necessary to delete this feature because we did not fully understand how the rules might change or even whether it would be advisable to be able to make these changes in an operating environment.

2.4 The Prototype System in Detail

2.4.1 The Operator Perspective

The details of the prototype system operation are described in Appendix A: Pilot Weather Information User Documentation.

2.4.2 The System Hardware

The prototype requires an IBM AT or 100% compatible "clone", with 640 kilobytes of Random Access Memory, a 30 Megabyte hard disk with 35 millisecond or better seek time, a floppy drive and a low-resolution monochrome monitor. A low-speed dot matrix printer with serial instead of parallel connector is required. The telephone-handling and voice generation is provided by Dialogic D40 and AMX80 add–on boards. Serial communications performance must be boosted by utilization of a serial port co-processor board with dual-ported RAM. In the case of the prototype, a Stargate ACL board was utilized. This board also relieves the necessity of

having standard serial port cards. Serial cables are required to connect the printer and the telex to the PWIS system. For high-quality voice recordings, a speaker and unidirectional, constant-level microphone, in combination with a low and high pass filter was employed. An ordinary telephone set can also be used for acceptable voice recordings.

The computational load and disk-intensive nature of the PWIS requires the performance level of the machine be AT class, rather than XT class. The additional hardware is capable of handling the higher clock rates offered on some AT clones. No additional internal power supply is required to accomodate the add-on boards, but these boards do take up 3 of the additional board slots provided in AT class machine.

No power filter or power-failsafe hardware was used, although this kind of precaution would likely be necessary in an actual application of the prototype to 24 hour a day service.

The voice file databases occupy about 10 megabytes of disk space for the ATS prototype. A current backup of these files must be available at all times, and therefore the PWIS can require a large quantity of floppy disks.

2.4.3 The System Software

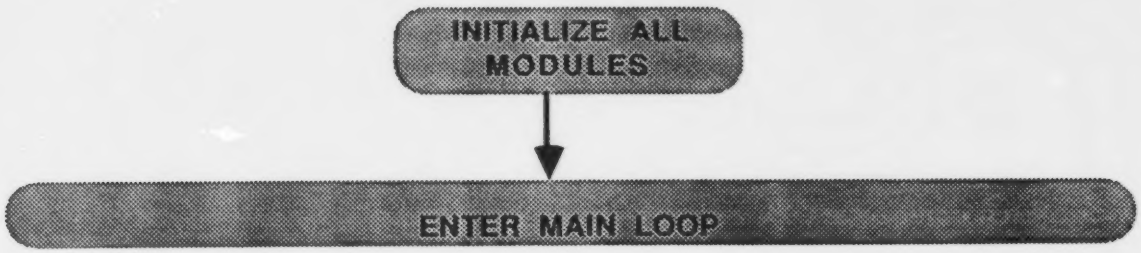
2.4.3.1 Organization of the Function Modules

Exhibit 2 provides an overview of the program's main loop, indicating each of the server functions and the tasks that they may perform. Realtime response considerations require that telephones, keyboard and telex all be served quickly and continuously, therefore each of these functional areas must be represented in the main loop. Report message file building has been placed in the main loop because it is such a sensitive issue for system performance.

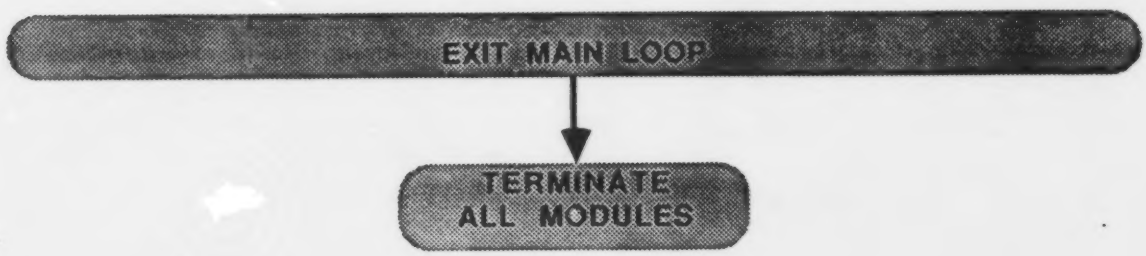
2.4.3.2 File Building

The file building modules carry out the transfer of pieces of speech, from the voice database where they are stored in relatively small phrases, to a single voice file representing an entire weather message, sometimes as long as

EXHIBIT 2. System Functional Overview



SERVER FUNCTION:	TASKS:
1.TELEPHONE HANDLER	• ACCEPT DTMF TONES • SPEAK PHRASES • HANGUP/PICKUP PHONES • ACCEPT RECORDINGS
2.KEYBOARD INPUT/PRINTER	• PRINT CHARACTERS • DISPLAY MESSAGES • VERIFY MESSAGES • CREATE TEXT AND RECORDINGS FOR MESSAGES
3. BUILD MESSAGES	• TRANSFER VOICE FILES SEGMENTS TO COMPOSITE MESSAGE FILE.
4.PROCESS TELEX	• SIFT TELEX STREAM FOR DESIRED REPORTS • PARSE REPORTS • TRANSLATE REPORT TOKENS TO TEXT AND SPEECH • PREPARE MESSAGE STRUCTURE



several senctences. It was found that by reducing the size of transfer to 2048 bytes per time, the file building process could be interleaved among the other system demands (such as performing other tasks "simultaneously") without negatively affecting sytem performance in those areas. Accordingly, circular queues were set up to handle the stacking of requests for message building, and the processing of requests was broken essentially into three functional modules: begin request, continue request, and end request.

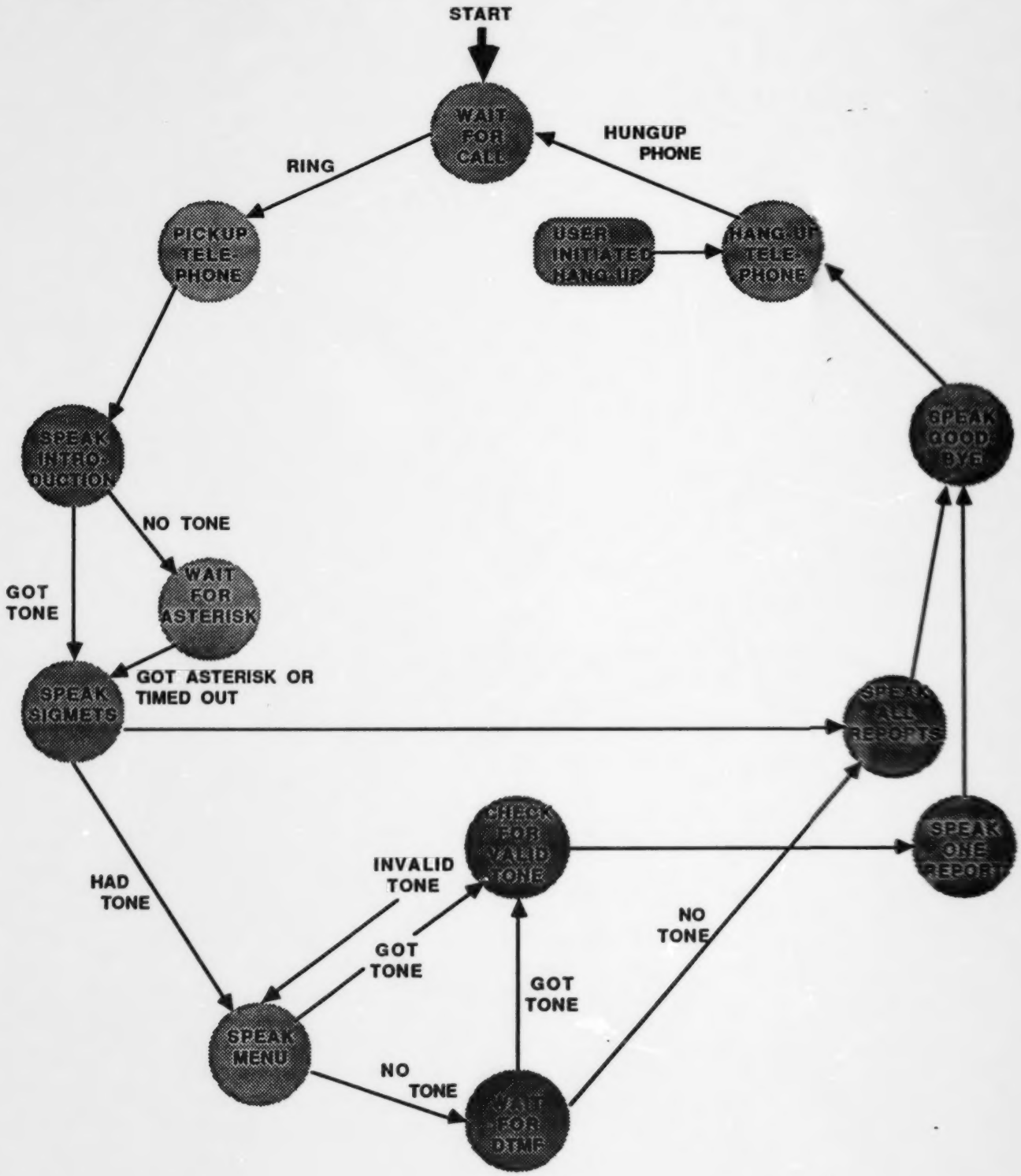
2.4.3.3 Telephone Handling

The Dialogic board is a muli-tasking processor which handles 4 or more telephone lines, DTMF detection and voice generation and recording simultaneously. The board interfaces with software on the AT through a device driver provided with the board. The device driver is designed to provide the software developer with an interface based upon a state machine model of activity, driven by an event queue. Exhibit 3 provides a conceptual illustration of a telephone caller state machine.

For the ATS prototype, the telephone interface was further sub-divided into two state machines: one for the recording station activities, and the other for handling telephone inquiries. Both state machines were developed in the prototype as hard-wired versions, so that each state change and each state transition function was determined by the software code and could only be changed at compile time. This approach was taken so that the prototype code could be put together quickly and cheaply. However, this approach has the limitation that any change to the telephone user menu, or even to the phrases spoken in some cases, may require code modifications. Some limited flexibility was designed into the software to handle each of the different report types in the same fashion.

Timing considerations for the telephone handler were important. The program must check the event queue regularly in order to field events generated by the telephone interaction which, for practical purposes, needs only be once every tenth of a second divided by the number of telephone lines, since the shortest event in telephone terms is a DTMF tone. However, the Dialog device driver requires refreshing more often than that when voice files are being played, because the driver must be allowed to fill and flush its speech file buffers. As the schedule for this activiy cannot be

EXHIBIT 3: Telephone User State Machine



determined outside of the device driver itself, the developer is put in the position of having to ensure solely that the telephone handler is serviced as often as possible while still managing to take a step forward on the other tasks facing the system.

2.4.3.4 The Keyboard/Printer Interface

The printer interface is fairly simple and timing is not a major problem here. Since the printer can wait for characters, the program just provides it with one character at a time through the main loop, when a printing request is active.

The keyboard/screen interface can be complex depending on the type and amount of display made, and on the data input from the keyboard. The prototype keyboard/screen interface was designed to handle adequately input of only one-character. This allowed the development of a series of very simple functions which could quickly display a command or menu, wait for a character, or start up a user function such as message display. During the development process several small exceptions to this process were made for string input.

The most complex screen function is required for managing the display of the text of a report, relative to its voice content when highlights are required of sections which needs recording. This function was left as a single unit.

All operator-activated functions are initiated from the screen and keyboard interaction; this also includes the voice recording function which is started and terminated from the keyboard. Many of these functions would probably take too long to execute if the program waited for their completion before servicing the telephone handler and other main loop server functions (which, as previously mentioned, requires constant monitoring).

To handle the timing considerations, the screen/keyboard server was implemented as a two-level state machine. The base level of the server is a state machine with several fixed–state cycles. One example of this is the screen menus which have the following functions: wipe the screen, draw a menu, look for a menu input character, display the character, transfer control to the function called by that character. Command lines have their own very similar fixed–state machine. The second level of the

screen/keyboard server provides the program with menu and command flexibility. Any menu or command can be set as the current or alternate function to be executed upon receipt of input. Coupled with hardwired functions which dictate what activity is invoked by a given input for a given command or menu the screen/keyboard server can cycle from state to state without any formal definition either of what the states are or what the possible transitions are.

Other than the screen message display noted above, no user functions in the PWIS require any real processing activity (e.g. such as a series of caculations, or intensive text processing needed for the telex reports) that cannot be passed off immediately to other parts of the program. For example, when a message is verified, that message is simply placed in the message-ready queue, to be processed by another part of the program.

By keeping the screen/keyboard server simple, this server had little impact on the performance of other modules, and it was possible to reduce the complexity of the task interleaving problem for the prototype.

2.4.3.5 Processing the Telex Stream

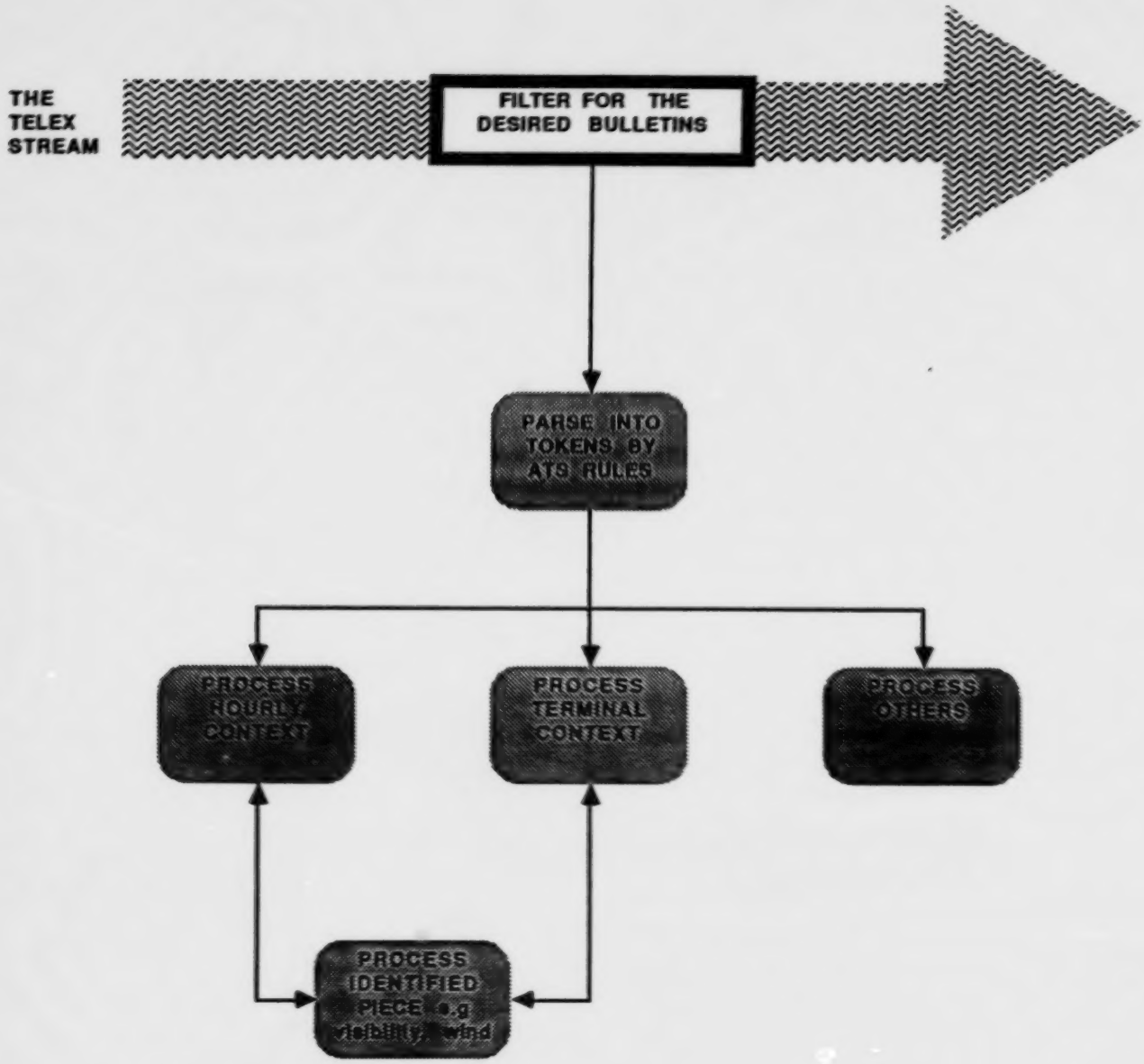
Exhibit 4 provides an overview of the software modules required to process the telex stream. Since the telex stream is continuously flowing, the serial co-processor is used to hold the stream sample until a bulletin can be isolated, captured, and examined to see if it is one of the bulletins desired for further processing. This approach considerably reduces the processing load of the micro-computer, which is not well-suited to handle constant volumes of serial data in the first place.

Once a desired bulletin is captured, its contents are saved for the second phase of telex processing, where the contents are parsed into text tokens according to a special set of rules appropriate to ATS and AES terminology.

The third stage of processing for telex data is specific to the character of the type of report: hourlies, terminals, or everything else. At this level of processing, the context problems associated with each report are dealt with.

Finally, as each section or token of the report is firmly identified by report subtype, it is either translated directly, or passed to utility routines designed

EXHIBIT 4. Processing the Telex Stream



to translate specific fields such as windspeed or visibility.

As the project proceeded, the problem of translating hourlies and terminals grew more complex. Originally, it appeared that there would be enough time to fully translate one report in one pass through the main loop. When this was not the case (because the system needed to deal with other activities as well) several accesses were allowed to the telephone handling software in the midst of the telex processing software. While this jury-rigged approach may be adequate for a prototype, the telex processing software will have to be considerably revised for an online system.

2.4.3.6 Connections

ATS telex reports pass through the PWIS software, starting with the telex processing, going through the operator editing, recording and verification process to be placed into the telephone menu, and finally, being removed from the system entirely. A set of three circular queue pairs, plus a two-dimensional array for the telephone messages, was used to manage the tracking and processing of the messages as they moved through the different stages in the PWIS.

2.5 Testing and Feedback

2.5.1 Evolution of ATS Requirements

Because of the nature of the project, specifically the lack of design specifications, the ATS requirements grew and changed over the course of the project. Several parts of the prototype were redesigned and reworked as those specifications developed. There were three areas of the prototype which changed the most:

- the automated translation process from the teletype reports,
- the handling of time/date stamps from the teletype and report updating.
- the handling of operator verification and editing.

2.5.2 ATS Teletype and theTest Data

ATS Vancouver made available the AES weather report distribution teletype circuit to Oracle for a period of several months. This teletype carried all reports used by ATS except NOTAMS. The availability of this test data was crucial to the development of the prototype.

2.5.3 Field Testing and Evaluating the Prototype

In August, 1987 ATS Vancouver had the pre-prototype system installed and demonstrated in their downtown offices for several weeks. The system was run and examined daily by one of their personnel and performance data recorded. The following revisions were made as a result of this test period:

- Permission of upper and lower case in the text entry,
- Provision of auto-verification of teletype reports for testing,
- Extension of the maximum length of temporary recordings,
- Correction of identified errors.

In November,1987 The Pilot Weather Information System prototype was installed at the Vancouver Airport for testing and evaluation until March 1988. A short training period for operations personnel will be followed by a testing period in two phases:

Phase 1. The prototype will be evaluated by Flight Service Specialists. All elements of the Transcribed Weather Broadcast must be evaluated and found acceptable to the project manager prior to proceeding with Phase 2.

Phase 2. The prototype will be tested in an On-line operational setting until March 31,1987.

Oracle will have access to the Flight Services Specialists operations room to install, maintain, and operate the prototype provided that this will not interfere with normal operations.

Oracle Communications will provide ATS with a statement of the parameters that they wish the Flight Service Specialists to evaluate. Oracle will also provide whatever additional training is necessary to operate the equipment and will be available to respond to requests for assistance and will input changes to the program for evaluation.

Preliminary indications are that the prototype system is working well. In particular it was noted by operations personnel that the system's recording capability alone is superior to the existing speech recording station.

3.0 CONCLUSION

Based on our experience with this project we can conclude that the iterative approach to product development, i.e. the "fly by the seat of your pants approach" instead of the product specification/design/development approach, can work. In fact, where the problem is reasonably well defined, and prototyping is relatively inexpensive, taking this approach can materially assist the design process by both identifying and testing practical problems and solutions.

The fact that several agencies were involved in the information creation/dissemination process, and that decision making often involved many Departments in different parts of the country made it difficult to get specific information about how all the parts of the system worked. This was particularly true for this project since the additional impact of schedule and budgetary constraints had to be considered.

Many times the design for the prototype had to change because either additional information or requirements were received or because previous information was incorrect. One example of this involved the decision to move from a fully automated system to one which required operator confirmation of messages and reports. In hindsight it seems obvious that since safety is paramount, the final responsibility for the information has to be assigned to a person rather than a computer. This change was significant not only for the new design features required but also on delivery

time and budget. This feature, more than any other required both changes to the existing approach and new additions. For example, operator editing features including off-line recording capability had to be added. Operator-created messages had to be spliced in with computer-generated messages.

Whether this type of problem could have been avoided if proper design and performance specifications had been available will remain unknown. We can speculate, however, and suggest that a system resulting from this process may not have been as sensitive to the operators requirements, i.e. as "operator friendly".

A good lesson that emerges from this process is that all participating agencies need to have a stake in the product to be developed and also be committed to it. This may require more "selling" of the idea or concept at the front end but it will save a greater amount of time (and pain) later on.

3.1 Implementing the Pilot Weather Information System

Although ATS will formally end its involvement with the project at the end of the operational test and, at this time, makes no commitment to acquire or pay for any future use of the prototype, all indications are that if the test is successful the system will be installed at the Vancouver airport. The translation feature of the system alone could provide significant savings in time and the system's recording station is easier to use and less expensive than existing method.

Oracle's previous demonstration of the prototype to senior ATS personnel from other regions was very positive and all indications are that a successful test and evaluation in Vancouver could lead to installations at airports across Canada.

The system has the capability of being installed at small remote and unmanned airports and provide local current weather information to pilots by telephone or over radio. The remote unit could be connected to a central station by standard telephone, cellular telephone or radio. Flight safety would be improved if current weather information was available at remote

locations. The system also has the capability to be expanded (with some menu modifications and a different data feed) into a low-cost fully automated flight planning tool.

An important issue arises with automated systems such as this one. When the safety of people is at stake, can final responsibility be assigned to a machine or will human intervention always be necessary? Artificial intellingence and other expert systems are already used in several applications where human safety may be an issue and there are many other potential applications waiting. The matter of manual versus automatic information dissemination needs to be reviewed.

3.2 Innovative Features of the Prototype

The prototype includes several technological achievements that will make it more attractive for other applications. These achievements were the result of making unique multi-processing and communications capability resident on a fairly typical micro-computer; secondly, the system is able to deal with unlimited vocabulary.

The prototype provides not only an inquiry-response capability but also monitors the teletype and telephone. The software was written in such a way that the prototype appears to be multi-tasking. This was a signficant achievement because of the scale of the application which a small size machine had to perform. We now know that other complex tasks can be performed on micro-based systems thereby opening many other opportunities in related areas such as marine and fishing applications and in unrelated areas.

Since the system had to deal with free format text input it required the incorporation of adaptive and expert system concepts. As described previously, some pattern recognition was necessary because of the contextual meaning of specific values. A certain value would mean one thing in one location and another thing in another location depending on context. Programming a system to deal with this type of information was a challenge.

Another challenge for the system was how it was to deal with unlimited

vocabulary. New words required by the system but not present in its pre-recorded vocabulary would be identified and highlighted for the operator who could then choose to record the whole message or only the required words. The system could be set up in such a way that each operator has a vocabulary of pre-stored words recorded in his own voice. Then when new words are required they can be recorded in his own voice thereby avoiding the problem of different recorded voices being assembled into speech messages.

The system could be modified to include an expandable permanent vocabulary. Once the system has indentified the new words required they can be recorded and added to the permanent vocabulary—and need never be recorded again.

3.3 Future Directions for the Technology

Recent advances in speech recognition, and artificial intelligence(AI) will likely have a significant effect on this type of system.

Speaker independent speech recognition, in particular, will make it much simpler for the public to access information and interact with the computer using simple English words or commands. This approach will permit universal access from any telephone and does not require DTMF tones to interact with the computer.

Unfortunately, currently available speaker independent systems have unacceptably low reliability for use outside the laboratory and particularly in applications where safety is a factor. It is evident, however, that computer speech technology is evolving quickly and will shortly integrate speech recognition into many non-military applications.

AI is also a field experiencing rapid advancement and application in many areas including robotics. Most successful AI applications involve knowledge based systems (also know as expert sytems) which operate in well defined and highly constrained applications where there is a large volume of specific knowledge about the particular application. In the automated information area, expert systems, and adaptive and self-learning computers could make a significant contribution. These

systems should be able to deal with any type of information whether formatted or unformatted. The policy question will remain: How much responsibility should be assigned to a machine?

The Transportation Development Centre should continue to support research and development in high technology systems applied to transportation. This support is even more important now at a time when technology is changing so rapidly and new policies may be required.

APPENDIX A . User's Manual

Pilot Weather Information User Documentation

Draft 1.0

PREPARED FOR AIR TRAFFIC SERVICES, VANCOUVER

BY

ORACLE COMMUNICATIONS, INC.

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A. Introduction

This documentation describes the beta test version of the Pilot Weather Information program, developed and owned by Oracle Communications, Inc. This software processes specified weather bulletins from the Atmosphere and Environment Services teletype circuit, or from operator input, and places a digital voice translation within a menu which can be heard by telephone callers who dial the lines connected to this system.

B. How to Use This Manual

For information about a specific menu item, display screen or command option, look in the index for a page number for that item. Other topics, such as trouble-shooting, handling of stale messages, and a general description of the system, are listed in the table of contents. The reader can follow through the table of contents in order to progressively review the detailed operations of the program.

C. General Description of the Pilot Weather Information System

The Oracle Pilot Weather Information system operates on a specially configured IBM AT computer. The system performs the following functions:

- Takes those hourly weather observation and terminal forecast messages that are reported by the Vancouver Flight Services Station from the AES telex circuit and decodes each into a text translation, also identifies transcribed weather broadcasts, PIREPS and SIGMETS,

- Places messages in a que for operator disposition, and notifies the operator that messages are waiting,

- Requires the operator to verify messages (as is, or after modification) and transfer them from the incoming que to "on-line" on the telephone,

- Allows the operator to perform a number of functions before putting messages "on-line", including: remove message, change the date/time stamp, edit text, edit voice, and verify message,

- Allows the operator to create new messages and place them "on-line", and

- Allows the operator to listen to and/or print "on-line" messages.

For the beta test, the Oracle system is taking messages from a telex circuit installed at the Air Traffic Services offices, 800 Burrard Street, and placing them in a telephone menu that can be reached by calling 666 - 0643.

(The demonstration is a single internal Transport Canada phone line. It may not answer if the demonstration is being modified, it may ring busy if someone else is trying the demonstration or the system is resetting the line. Do not press the asterisk key as requested by the menu. This will transfer the call to a Transport Canada operator.)

D. Pilot Weather Information Menus, Commands and Screens

The **MAIN MENU** is composed of the first six major items that follow.

1. Select Operating Options

1.1 Set Timestamp

The user will be shown the day, hour and minute of the computer's system clock. This timestamp is used to check the validity of timestamps on incoming hourly bulletins, and to turn over the hourly messages when the first bulletin of the hour comes in.

It is necessary that the system clock maintain the same timestamp as that correct Universal Time for the weather bulletins.

The user can set the system date and time correctly upon booting the machine, or use this menu item to advise the program of the timestamp it should be using. Once the program timestamp has been correctly set, it need not be reset unless the program is exited and re-started. (If setting the date/time stamp, be sure to enter 01....02....etc. for dates under 10, and add seven hours to the local clock setting for Universal Time.)

1.2 Operator Initials

The user may enter his/her initials, which are used to identify any message that is operator created.

1.3 Set Bell Interval

The system bell will ring every 45 seconds while there is a message waiting to be

processed. The operator can increase this time interval by entering a number which is used to multiply the interval (ie. enter '3' and the interval becomes 3 * 45 = 3 minutes). Entering 0 turns the bell off, and entering 1 returns the bell to 45 seconds.

1.4 Toggle Autoverify

If an operator is not available to verify messages over several hours, the incoming que will become too large for the system to store. Accordingly, the demonstration allows messages to be verified automatically by setting this toggle. If the system is autoverifying, this condition will appear on the Main Menu screen.

1.5 Other Operating Options

These are generally for use by the developer.

2. List Online Messages

The **Choose Message Type** screen appears and the user to selects the type of message to list. The **Listing** screen appears and asks the user to choose between the printer and the display screen for the listing. In the case where the user chooses the printer the messages will begin printing in the order that they would be heard by a telephone caller, and the user is returned to the **Main Menu.** In the case where the user chooses the display, the **Listing** screen shows each message individually and permits the following commands:

2.1 Remove

Mark a message to be removed. The message will be removed right after the operator leaves the List Online Messages function. Therefore, if the operator would like to reverse the decision to remove, it can be done at any time before leaving **List Online Messages.**

2.2 Show Timestamp

Shows the user the day, hour, and minute of the timestamp associated with that message.

2.3 Previous and Next

The messages are shown one by one, in the order that they will be heard by a telephone caller. The command **"Previous"** returns the user to the previous message,

or the prompt **"First message"** will appear if there is no previous message. The command **"Next"** message moves the user on to the next message, or shows **"Last message"** if there are no more messages.

2.3 Arrow Keys

When the weather message is too big for the screen, the arrow keys can be used to move the message by screenfuls. The left and right arrow keys move the translated text either left or right. The up and down arrow keys move the raw text either left or right.

2.4 Quit

Returns the user to the **Main Menu**.

3. Create New Message

The **Choose Message Type** screen appears and the user to selects the type of message to create. The next screen to appear is the **Insert Text** screen (described in detail in Section 10).

4. Edit Telex Message

This option can only become active when the screen shows the following prompt: **"Telex message needs editing"**. The program will only show this prompt if a designated weather telex or operator-created message has come in that cannot be fully translated. Otherwise, if selected , the **Main Menu** will remain and a message will be shown **"No message to edit"**.

The user is moved to the **Edit Message** screen (described in detail in Section 8), where the message can be changed or sent on to the verfication process.

5. Verify Telex Message

This option can only become active when the screen shows the following prompt: **"Telex message needs verifying"**. The program will show this prompt when a designated weather telex or operator-created message has come in that has been fully translated. Otherwise, if selected , the **Main Menu** will remain and a message will be shown **"No message to verify"**.

The user is moved to the **Verify Message** screen (described in detail in Section 7),

where the message can be placed online, removed or further edited.

6. Quit the program

As this program is intended to be in 24 hour operation, this option exists only to provide a graceful exit at times when the equipment is being maintained or software changed. The user will be asked to confirm their request to quit the program before the action will proceed.

7. VERIFY MESSAGE SCREEN

When the operator selects "verify message" from the Main Menu, this screen comes up and shows the weather message that the operator is being asked to verify. As is the case for all screens which show weather messages, the screen is split into two halves horizontally. The top half shows the message in the raw form, as it was received from the telex, or from the operator on a request for translation. The bottom half of the screen shows the translation of the raw message that the program has made. If the message has a timestamp that the program considers erroneous, the prompt **"Doubtful Timestamp"** will be shown.

The operator should peruse the message and decide what to do with it. The following command options exist:

7.1 Change Timestamp

Whether or not the prompt **"Doubtful Timestamp"** is showing, the operator may choose to change the timestamp associated with a message. This change will be reflected in the message translation if the reporting protocol calls for the timestamp to be spoken to the telephone caller.

7.2 Online

The message is placed in the telephone caller menu according to the message type. The operator is returned to the **Main Menu**.

7.3 Remove

The message is removed without being placed in the telephone caller menu. The operator is returned to the **Main Menu**.

7.4 Edit

The user is moved to the **Edit Message** screen (described in detail in Section 8), where the message can be changed or sent on to the verfication process.

7.5 Quit

The operator is returned to the **Main Menu**, and the message remains, waiting to be verified.

8. EDIT MESSAGE SCREEN

When the operator selects edit message from the Main Menu, this screen comes up and shows the weather message to be edited. As is the case for all screens which show weather messages, the screen is split into two halves horizontally. The top half shows the message in the raw form, as it was received from the telex, or from the operator on a request for translation. The bottom half of the screen shows the translation of the raw message that the program has made.

Actions in the **Edit Message** screen apply only to the translated message, that is, the bottom half of the screen.

The **Edit Message** screen is the most versatile part of the program. The actions that can be taken branch first of all into two modes: actions which apply to the **whole** message; actions which apply to a speech **unit** of the message. The speech unit refers to the fact that the raw message is translated into words or phrases according to the way in which the vocabulary was recorded.

8.1 Whole Mode

In **Whole** mode, the operator has the following command options:

8.1.1 Listen

The operator has a special connection to the audio part of the program, which allows both listening and recording of speech.

The operator can pick up the special phone, hit the **Listen** command, and hear each speech unit of the message, in order. Hitting any keyboard key will stop this process. This function can be used to verify that the message as shown on the screen contains the speech that the operator expects. As each unit is to be played, it is highlighted.

8.1.2 Print

The operator can print this message.

8.1.3 Re-do

This command allows the operator to scrub the entire translated text and speech for the message on the screen. A confirmation of this action is required.

The operator will be moved to the **Insert Text** screen (described in detail in section 10). Here the new text and speech for this message can be created.

8.1.4 Verify

Moves the user to the Verify Message screen. (see Section 7)

8.1.5 Arrow Keys

When the weather message is too big for the screen, the arrow keys can be used to move the message by screenfuls. The left and right arrow keys move the translated text either left or right. The up and down arrow keys move the raw text either left or right.

8.1.6 Unit

Moves the user to Unit mode, described below.

8.2 Unit Mode

In **Unit mode**, the operator can change, delete or replace parts of the message without disturbing other parts of the message. The operator can see which unit of the message is currently chosen because the translated text is highlighted. By pressing the return key the operator can move to the next unit, and by pressing the backspace key the operator can move to the previous unit. As is the case in **Whole mode**, the arrow keys allow the message to be moved by screenfuls. The following commands are available:

8.2.1 Delete

The highlighted text and corresponding speech will be removed immediately from the message. There is no undo command for this deletion.

8.2.2 Listen

The operator has a special connection to the audio part of the program, which allows both listening and recording of speech.

The operator can pick up the special phone, hit the **Listen** command, and hear the currently highlighted speech unit of the message. Hitting any keyboard key will stop this process.

This function can be used to verify that the message as shown on the screen contains the speech that the operator expects.

8.2.3 Insert before cursor

A new text and speech unit can be created in the spot just before the unit that is currently hightlighted by the cursor. The operator is placed in the **Insert Text** screen (for details of this screen, see Section 10). After the new unit is created, the operator is returned to the **Edit Message** screen in **Unit** mode.

8.2.4 Whole

The operator is returned to Whole mode.

8.2.5 Verify

Moves the user to the Verify Message screen. (see Section 7)

9. INSERT TEXT SCREEN

Here the user is prompted to enter the new text and/or hit return when this task is complete. The user then has the following commands to choose from:

9.1 Edit

The user is moved to the **Edit Message** screen (described in detail in section 8), where the message can be changed or sent on to the verfication process.

9.2 Record

The user is moved to the **Record Message** screen (described in detail in Section

10), where a recording can be associated with the new text that was entered.

9.3. Mark for Translation

The message is so marked. This means that if and when the user verifies the message and chooses to place it online then the message will go through a text-to-speech translation and return for the operator to verify/edit again. This process allows the operator to create a new message from the existing vocabulary without having to record any new speech.

The user is moved to the **Edit Message** screen (described in detail in section 8), where the message can be changed or sent on to the verfication process.

9.4 More than One "Bad Spot"

For telex or operator-created messages which have been translated, there may be more than one place in the message which needs new text and some recording. Such messages will cycle through from **Insert Text** to **Record Message** or **Mark for Translation. Edit Message** cannot be chosen until all such "bad spots" are dealt with.

10. RECORD MESSAGE SCREEN

This screen is arrived at by selecting **Record** from the **Insert Text** screen. Raw and translated messages show on the top and bottom of the screen as they do in other message screens. However, the operator cannot alter the placement of the messages on the screen. The program detemines the placement so that the spot in the raw message which needs recording and the spot in the translated message where the corresponding text exisits are both on the screen at the same time.

The operator is prompted to start the recording process or use the ESCAPE key to avoid recording anything. This option is required since a recording of silence is in fact filled with noticable white noise.

Then the operator is prompted to begin speaking and to hit any key when the speech to be recorded is complete. This will return the operator to the **Insert Text** screen if there are more "bad spots" or to the **Edit Message** screen if the recording is for a single speech unit.

11. START UP SCREEN

The operator must select the language the system is to produce speech and translations in, before the program can properly begin.

E. Speech Vocabulary

A database of words or phrases corresponding to the equivalent spoken expression is used by the program to translate AES codes, and also to produce the speech corresponding to a given weather message.

At present, the program is operating with a limited vocabulary, adequate to translate the Aviation Weather Observations and the Terminal Forecasts only. New vocabulary and new abbreviations or acronyms for old vocabulary can only be added to the program in a off-line process.

F. Problems and Troubleshooting

This version of the program is a beta test version. This means that while the program has been exhaustively tested by the developers inhouse, it has not been field-tested. Due to the stage of development of the program, it is possible that the program may fail entirely in one of the two following ways:

F.1 Frozen Screen

The program will not respond to legitimate menu or command choices. Please write down any program activity which may have occurred just before the program froze. Please call Oracle.

Turn the machine off and re-boot.

F.2 Fatal Error Message

The program dies and leaves a "Fatal Error" message on the screen. Please write down the error number, any preceeding message (probably repeated a number of times) and any program activity which may have occurred just before the program died. Please call Oracle.

Turn the machine off and re-boot.

F.3 Speech Impairment

The messages for the telephone callers pause, miss small portions of speech, or hiccup. Alternatively, an entire speech unit or message is composed of white noise. Please note which condition occurs. Please call Oracle.

Turn the machine off and re-boot.

F.4 Speaker Clicks

The speaker issues a number of rapidly repeating clicks, likely accompanied by speech impairment. Please call Oracle.

Turn the machine off and re-boot.

F.5 Telephone Call-in Difficulties

Upon calling the telephone number for the program, the program won't answer, gives a busy signal or hangs up in the middle of the menu. Please note which condition occurs. Please call Oracle.

Turn the machine off and re-boot.

F.6 Other

Please call Oracle. Leave the machine as is.

G. Automatic Message Removal or Turnover Rules

According to the instructions given by ATS staff, the following rules are applied to message updating:

G.1 Aviation Weather Observations

The messages all update after receipt of the first bulletin of the new hour. Those stations for which a new message has come in have the old one replaced. Those stations which have a message for the last hour but no message for the new hour have their message changed to indicate the time at which that message came in. Stations which have only a message two hours old have those messages replaced by a short message indicating the station's weather report is delayed.

Specials incorporate the altimeter, temperature and dewpoint from the previous message, if available.

G.2 Terminal Forecasts and Transcribed Weather Broadcasts

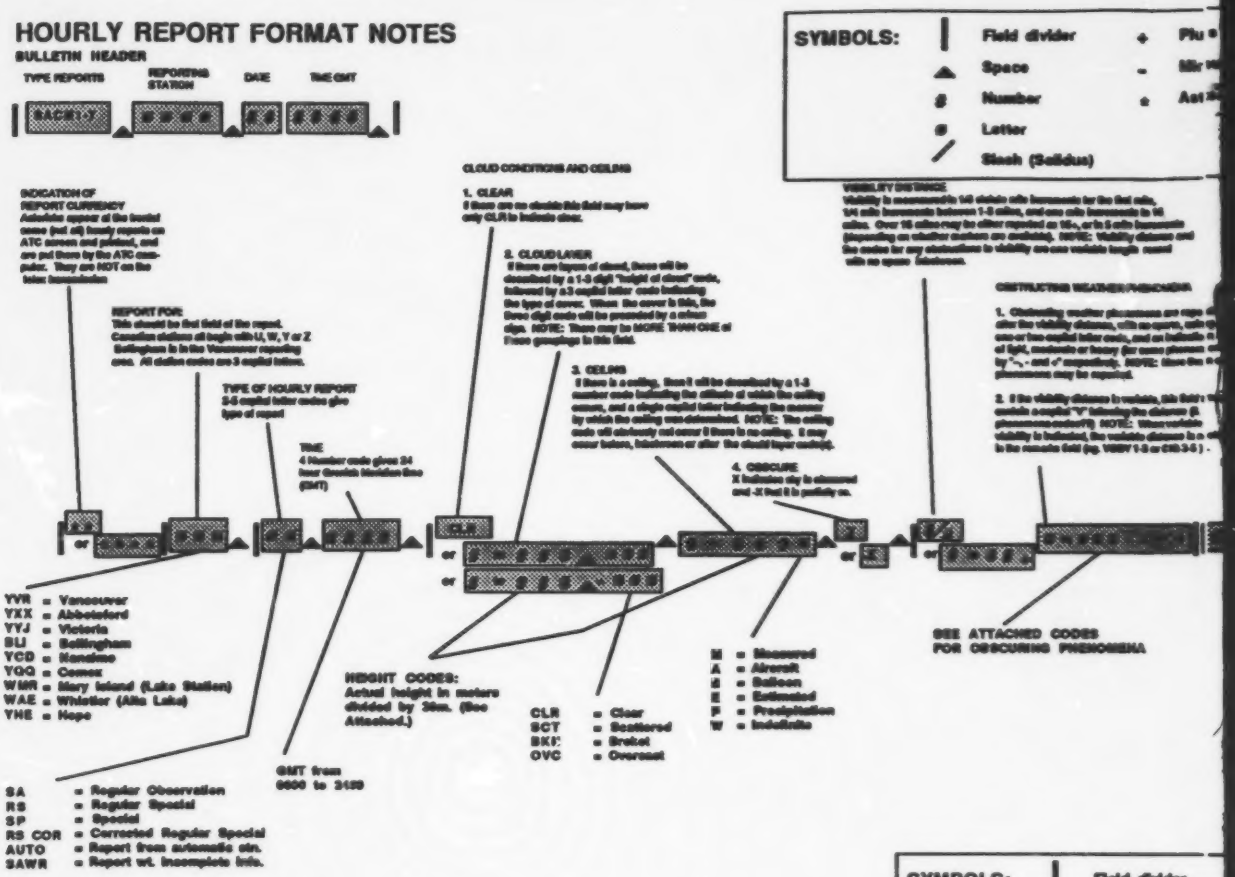
The current message (for a station, in the case of Terminal Forecasts) is replaced by the incoming message.

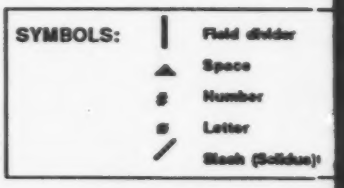
G.3 Sigmets, Pireps, and Notams

As these messages are only entered manually in the present system, and since, with the exception of Sigmets they have no specified removal procedure, they can only be deleted manually by the operator.

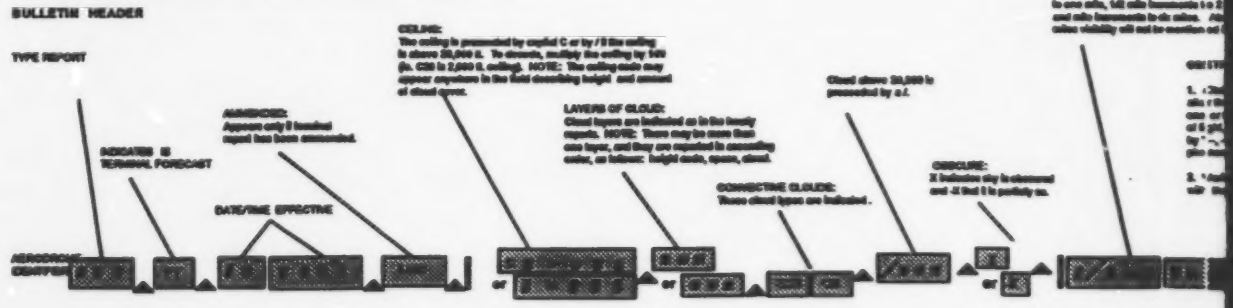
APPENDIX B. Analysis of Weather Bulletins

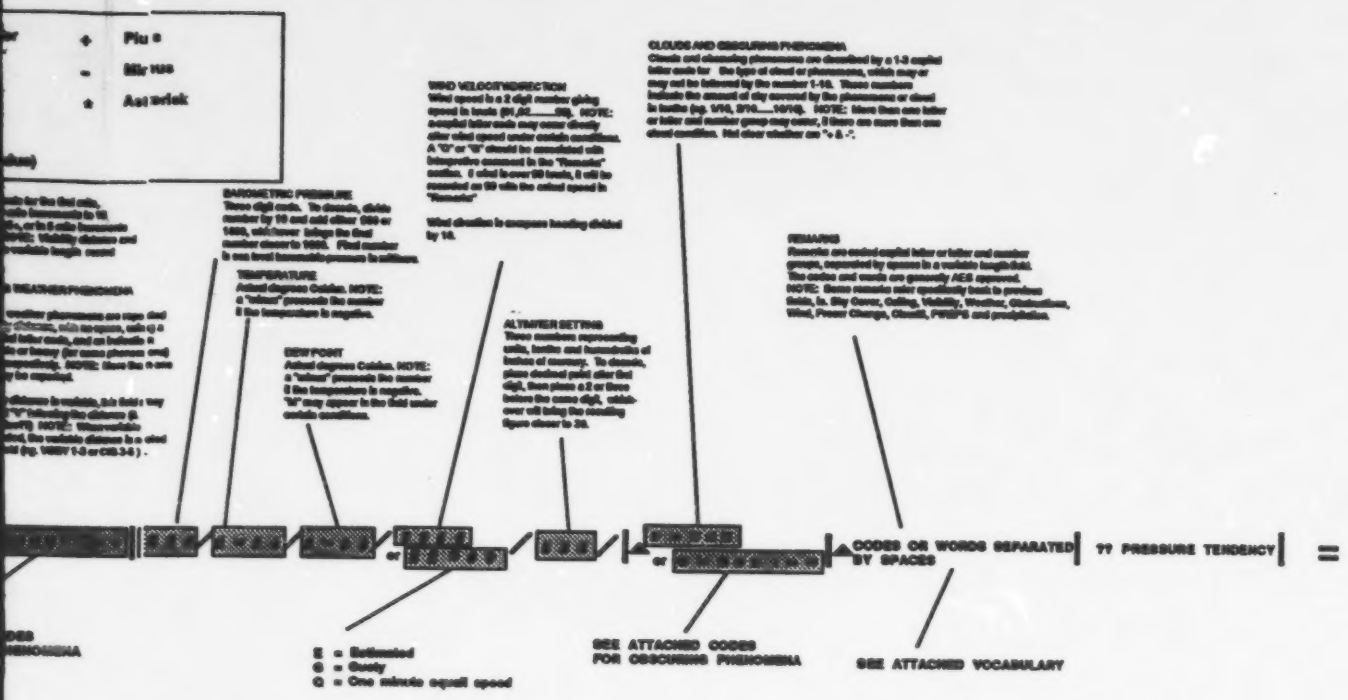
HOURLY REPORT FORMAT NOTES

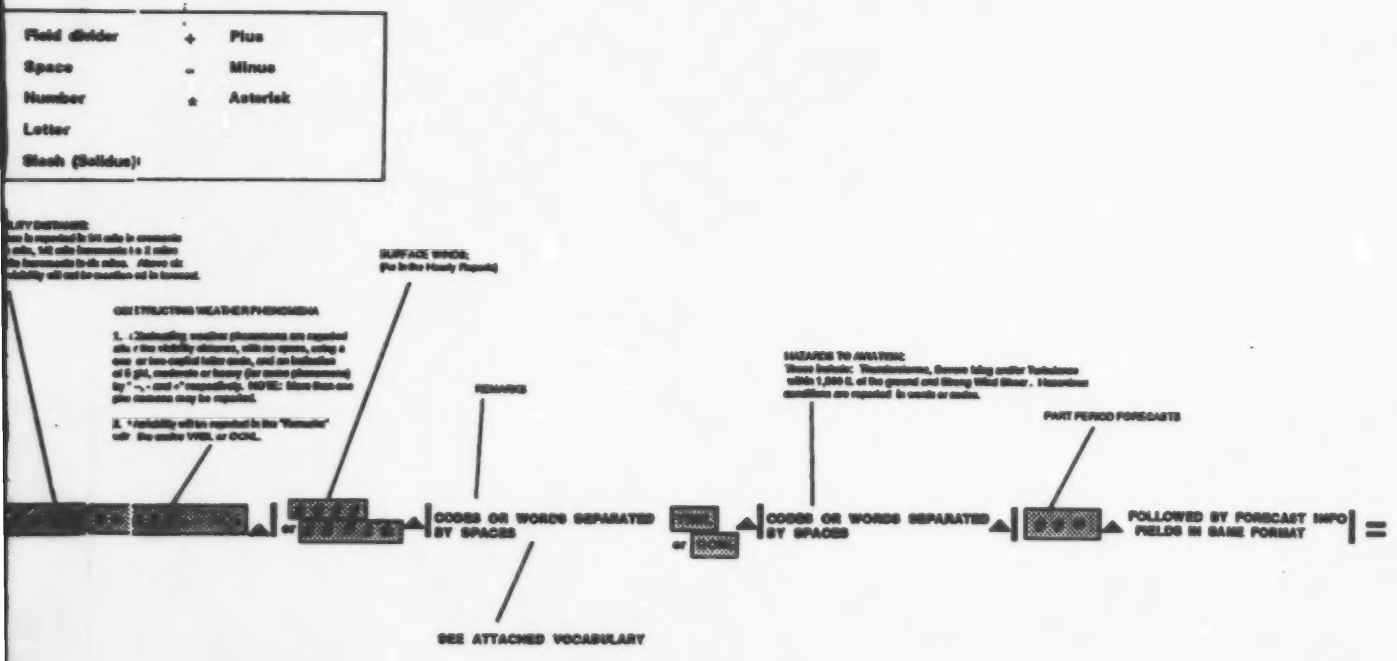




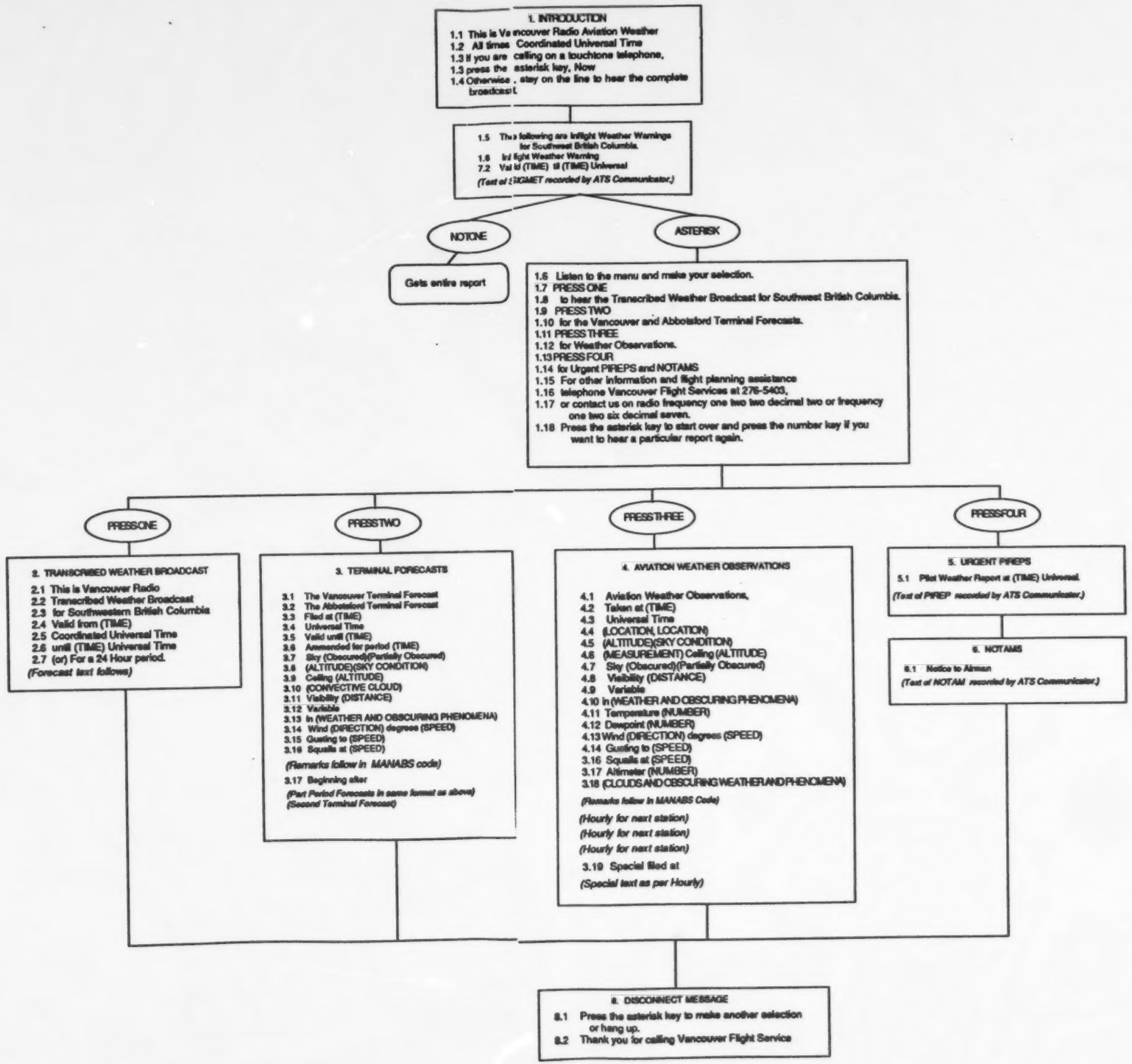
AERODROME REPORT FORMAT NOTES




+ Plus
- Minus
* Asterisk
WIND VELOCITY/DIRECTION
BAROMETRIC PRESSURE
TEMPERATURE
DEW POINT
ALTIMETER SETTING
CLOUDS AND OBSCURING PHENOMENA
REMARKS
or
or
CODES OR WORDS SEPARATED BY SPACES
99 PRESSURE TENDENCY
=
E = Estimated
G = Gusty
C = One minute squall speed
SEE ATTACHED CODES FOR OBSCURING PHENOMENA
SEE ATTACHED VOCABULARY


Field divider
Space
Number
Letter
Slash (Solidus)
+ Plus
- Minus
* Asterisk
OBSTRUCTING WEATHER PHENOMENA
SURFACE WIND:
REMARKS
HAZARDS TO AVIATION:
PART PERIOD FORECASTS
or
or
CODES OR WORDS SEPARATED BY SPACES
CODES OR WORDS SEPARATED BY SPACES
FOLLOWED BY FORECAST INFO FIELDS IN SAME FORMAT
=
SEE ATTACHED VOCABULARY

APPENDIX C. Telephone Menu


1. INTRODUCTION
1.1 This is Vancouver Radio Aviation Weather
1.2 All times Coordinated Universal Time
1.3 If you are calling on a touchtone telephone,
1.3 press the asterisk key, Now
1.4 Otherwise , stay on the line to hear the complete broadcast
1.5 The following are Inflight Weather Warnings for Southwest British Columbia.
1.6 Inflight Weather Warning
7.2 Valid (TIME) til (TIME) Universal
(Text of SIGMET recorded by ATS Communicator.)
NOTONE
Gets entire report
ASTERISK
1.6 Listen to the menu and make your selection.
1.7 PRESS ONE
1.8 to hear the Transcribed Weather Broadcast for Southwest British Columbia.
1.9 PRESS TWO
1.10 for the Vancouver and Abbotsford Terminal Forecasts.
1.11 PRESS THREE
1.12 for Weather Observations.
1.13 PRESS FOUR
1.14 for Urgent PIREPS and NOTAMS
1.15 For other information and flight planning assistance
1.16 telephone Vancouver Flight Services at 276-5403,
1.17 or contact us on radio frequency one two two decimal two or frequency one two six decimal seven.
1.18 Press the asterisk key to start over and press the number key if you want to hear a particular report again.
PRESS ONE
2. TRANSCRIBED WEATHER BROADCAST
2.1 This is Vancouver Radio
2.2 Transcribed Weather Broadcast
2.3 for Southwestern British Columbia
2.4 Valid from (TIME)
2.5 Coordinated Universal Time
2.6 until (TIME) Universal Time
2.7 (or) For a 24 Hour period.
(Forecast text follows)
PRESS TWO
3. TERMINAL FORECASTS
3.1 The Vancouver Terminal Forecast
3.2 The Abbotsford Terminal Forecast
3.3 Filed at (TIME)
3.4 Universal Time
3.5 Valid until (TIME)
3.6 Ammended for period (TIME)
3.7 Sky (Obscured)(Partially Obscured)
3.8 (ALTITUDE)(SKY CONDITION)
3.9 Ceiling (ALTITUDE)
3.10 (CONVECTIVE CLOUD)
3.11 Visibility (DISTANCE)
3.12 Variable
3.13 In (WEATHER AND OBSCURING PHENOMENA)
3.14 Wind (DIRECTION) degrees (SPEED)
3.15 Gusting to (SPEED)
3.16 Squalls at (SPEED)
(Remarks follow in MANABS code)
3.17 Beginning after
(Part Period Forecasts in same format as above)
(Second Terminal Forecast)
PRESS THREE
4. AVIATION WEATHER OBSERVATIONS
4.1 Aviation Weather Observations,
4.2 Taken at (TIME)
4.3 Universal Time
4.4 (LOCATION, LOCATION)
4.5 (ALTITUDE)(SKY CONDITION)
4.6 (MEASUREMENT) Ceiling (ALTITUDE)
4.7 Sky (Obscured)(Partially Obscured)
4.8 Visibility (DISTANCE)
4.9 Variable
4.10 In (WEATHER AND OBSCURING PHENOMENA)
4.11 Temperature (NUMBER)
4.12 Dewpoint (NUMBER)
4.13 Wind (DIRECTION) degrees (SPEED)
4.14 Gusting to (SPEED)
3.16 Squalls at (SPEED)
3.17 Altimeter (NUMBER)
3.18 (CLOUDS AND OBSCURING WEATHER AND PHENOMENA)
(Remarks follow in MANABS Code)
(Hourly for next station)
(Hourly for next station)
(Hourly for next station)
3.19 Special filed at
(Special text as per Hourly)
PRESS FOUR
5. URGENT PIREPS
5.1 Pilot Weather Report at (TIME) Universal.
(Text of PIREP recorded by ATS Communicator.)
6. NOTAMS
6.1 Notice to Airman
(Text of NOTAM recorded by ATS Communicator.)
8. DISCONNECT MESSAGE
8.1 Press the asterisk key to make another selection or hang up.
8.2 Thank you for calling Vancouver Flight Service

APPENDIX D. Examples of Vocabulary Used

General

Broadcast
Line
Visibilities
Front
Wind Shear
Cloud
Clouds
Tops
Condition
Conditions
Coast
Inland
Airmass
Air
Flight
Precaution
Precautions
System
Ceilings
Visibilities
Turbulance
Terrain
Layer
Knots
Surface
Ridge
Pressure
Level
Levels
Showers
Time
Times
Turbulence
Icing
Morning
Evening
Afternoon
Night
Day
Overnight
Tonight
Tomorrow
Today
Area
Areas
Precipitation
Mile
Miles
Feet
Metres
Lee
Windward
Flow

PRESS ONE
PRESS TWO
PRESS THREE
PRESS FOUR
PRESS FIVE
PRESS SIX
PRESS SEVEN
PRESS EIGHT
PRESS NINE
PRESS THE ASTERISK KEY
PRESS THE NUMBER KEY
PRESS THE ZERO KEY

A
And
The
Or
Either
To
This
That
So
Well
due
There
All
Through
However
Than
Between
As

At
Of
In
Out
On
Over
Beyond
Off
From
Before
After
During
Until
Til
By
Earlier
Later
Based
Due
Just
Except
Near
Between
Ahead
Behind
Above
Below
Aloft
Very
Less
More

Solid
Urgent
Low
Lower
High
Higher
Fast
Faster
Slow
Slower
Slowly
Occasional
Occasionally
Frontal
Moist
Unstable
Mid
Late
Early
Calm
Cold
Warm
Mild
Dry
Wet
Intermittent
Topped
Embedded
Convective
Heavier
Lighter
Extensive
Local
Regional
Areawide
Freezing
Exposed
Patchy
Odd
Isolated
Few
General
Generally
Thicken
Thickening

Be
Become
Becoming
Begin
Beginning
Are
Will
Will be
Has
Moved
Moving
Slowely
Missing
Delayed
Leave
Leaving
Give
Giving
Reducing
Form
Forming
Spread
Peak
Peaking
Spreading
Cause
Causing
Veering
Veer
Expect
Expecting
Advise
Advised
Advising
Improve
Improving
Increase
Increasing
Decrease
Decreasing
Reduce
Reducing
Develop
Developing
Diminish
Diminishing
Result
Resulting
Follow
Following
Backing

Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday
January
February
March
April
May
June
July
August
September
October
November
December
Ninteen Eighty Seven
Nineteen Eighty Eight

Visibility Weather & Obstr. Phenom.

Visibility
Variable
in

Very Light
Light
Moderate
Heavy
Severe
Risk
Tornado
Waterspout
Funnel Cloud
Thunderstorm
Severe
Thunderstorm
Very Light Rain
Light Rain
Rain
Heavy Rain
Very Light Rain
Showers
Light Rain
Showers
Rain Showers
Heavy Rain
Showers
Very Light
Drizzle
Light Drizzle
Drizzle
Heavy Drizzle
Very Light
Freezing Rain
Light Freezing
Rain
Freezing Rain
Heavy Freezing
Rain
Very Light
Freezing Drizzle
Light Freezing
Drizzle
Freezing Drizzle
Heavy Freezing Drizzle
Very Light Snow
Light Snow
Snow
Heavy Snow
Very Light Snow Grains
Light Snow Grains
Snow Grains
Heavy Snow Grains
Ice Crystals
Very Light Ice Pellets
Light Ice Pellets
Ice Pellets
Heavy Ice Pellets
Very Light Ice Pellet Showers
Light Ice Pellet Showers
Ice Pellet Showers
Heavy Ice Pellet Showers
Very Light Snow Showers
Light Snow Showers
Snow Showers
Heavy Snow Showers
Very Light Snow Pellets
Light Snow Pellets
Snow Pellets
Heavy Snow Pellets
Very Light Hail
Light Hail
Hail
Heavy Hail
Fog
Ice Fog
Haze
Smoke
Blowing Snow
Blowing Sand
Blowing Dust
Dust Haze

Numbers

Zero
One
Two
Three
Four
Five
Six
Seven
Eight
Nine
Ten
Eleven
Twelve
Thirteen
Fourteen
Fifteen
Sixteen
Seventeen
Eighteen
Nineteen
Twenty
Thirty
Forty
Fifty
Sixty
Seventy
Eighty
Ninty
Hundred
One Hundred
Two Hundred
Three Hundred
Four Hundred
Five Hundred
Six Hundred
Seven Hundred
Eight Hundred
Nine Hundred
Thousand
One Thousand
Two Thousand
Three Thousand
Four Thousand
Five Thousand
Six Thousand
Seven Thousand
Eight Thousand
Nine Thousand
Ten Thousand
Eleven Thousand
Twelve Thousand
Eighteen Thousand
Nineteen Thousand
Twenty Thousand
Over Twenty Thousand
More than Fifteen
One Eighth
One Quarter
Three Eighths
One Half
Five Eighths
Three Quarters
One and One Quarter
One and One Half
One and Three Quarters
Two and One Quarter
Two and One Half
Twenty Five
Thirty Five
Forty Five

phrases

This is Vancouver Radio Aviation Weather.
All times Coordinated Universal Time.
If you are calling on a touchtone telephone,
Press the asterisk key,
For the specific information you want.
Otherwise, stay on the line to hear the complete broadcast
Listen to the menu and make your selection.
To hear the Transcribed Weather Broadcast for Southwest British Columbia.
For the Vancouver and Abbotsford Terminal Forecasts.
For Weather Observations.
For Urgent PIREPS and NOTAMS
For other information and flight planning assistance
Telephone Vancouver Flight Services at 276-5403,
Or contact us on radio frequency one two two decimal two or frequency one two six decimal seven.
Press the asterisk key to start over
Press the number key if you want to hear specific report again
This is Vancouver Radio
Transcribed Weather Broadcast
For Southwestern British Columbia
Valid from
Coordinated Universal Time
Universal Time
Universal
For a 24 Hour period.
The Vancouver Terminal Forecast
The Abbotsford Terminal Forecast
Filed at
Universal Time
Valid until
Ammended
Ammended for period
Corrected
Corrected for period
Aviation Weather Observations
Taken at
Special filed at
Press the asterisk key to make another selection
or hang up.
Thank you for calling Vancouver Flight Service
Pilot Weather Report at
Notice to Airman
Inflight Weather Warning
Beginning after

Ceiling & Sky

Sky obsured
Sky partially obscured
Clear
Ceiling
Measured Ceiling
Aircraft Ceiling
Balloon Ceiling
Estimated Ceiling
Precipitation Ceiling
Indefinite Ceiling
Scattered
Broken
Overcast
Light Scattered
Light Broken
Light Overcast
Variable
Towering Cumulus
Cumulonimbus